SAMINCO

ELECTRIC TRACTION DRIVES

A300 SERIES MOTOR CONTROLLER USER MANUAL

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On Cover: A300 Series Motor Controller

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1 General Information

This document outlines the installation, operation and troubleshooting of the Saminco A300 Series Motor Controller. Please read and understand this manual before carrying out installation, inspection, maintenance, operation or repair of this equipment or its components.

Within this document, the product known as the Saminco A300 Motor Controller shall be referred to as the A300.

Some exceptional features of the A300 are listed below:

- Adjustable traction control
- Modular construction
- High efficiency power conversion
- Safety circuits for maximum protection of personnel and components
- External drive display for ease of monitoring and troubleshooting
- Power semiconductors used wherever possible to replace electro-mechanical switchgear
- Stepless acceleration and braking
- Selectable dynamic braking or line regenerative braking blended with dynamic braking
- Wheel slip and slide detection

1.1 Safety

THE A300 IS A HIGH POWER UNIT THAT CAN CAUSE SEVERE INJURY OR DEATH IF NOT USED PROPERLY. FOR YOUR OWN SAFETY, PLEASE REVIEW THE FOLLOWING WARNINGS FULLY BEFORE PROCEEDING.

1. **READ THIS MANUAL ENTIRELY BEFORE INSTALLING OR OPERATING THE A300.**
2. **DO NOT CONNECT OR DISCONNECT WIRING, CONNECT OR DISCONNECT WHILE THE HIGH VOLTAGE POWER SUPPLY IS TURNED ON.**
3. **THE A300 HAS INTERNAL CAPACITORS THAT ARE STILL CHARGED EVEN AFTER THE POWER SUPPLY IS TURNED OFF. TO PREVENT ELECTRICAL SHOCK, DISCONNECT ALL POWER, AND WAIT A MINIMUM OF FIVE MINUTES BEFORE TOUCHING INTERNAL COMPONENTS.**
4. **DO NOT PERFORM A WITHSTAND VOLTAGE TEST OR MEGGER TEST ON ANY PART OF THE A300. THIS ELECTRONIC EQUIPMENT USES SEMICONDUCTORS AND IS VULNERABLE TO HIGH VOLTAGE.**

1.2 Specifications

The specifications are outlined in Table 1 to Table 6, below.

Table 1: Mechanical and Environmental Requirements

A300510 DUAL SHUNT MOTOR CONTROLLER SPECIFICATIONS

Description	Specification
Operation	
Unit Weight	600lbs
External Dimensions	See Figure 5: Mounting Connection Drawing for details.
Ingress Protection Level	NEMA 12
Ambient Operating Temperature	-20°C to +50°C
Operating Altitude	1000 m, De-Rate 1% Power for each additional 100 m

Description	Specification
Relative Humidity	100%
Vibration	3g 10Hz to 500hz
Shock	50g ½-sinewave, 10ms
Storage – See Section 1.4 for other Storage Details.	
Storage Altitude (Maximum)	3000m
Storage Temperature Range	-40°C to +70°C

Table 2: Output Ratings

Description	Specification
Current	600A DC continuous
1 Minute Overload Capability	900A DC
Grounding Configurations	Grounded Negative
Output terminal dV/dt	1500 volts per microsecond (maximum)
Switching Frequency	1kHz
Thermal Dissipation	Standby: 120 watts At rated output current 800A, 50% Duty Cycle: 1410W

Table 3: Main Power Supply

Description	Specification
Supply Bus Voltage	420V to 720V DC continuous
Maximum Peak Voltage	1000V for 1sec. transient 10,000V for 50µs transient
Supply Current Required	600A continuous

Table 4: Control I/O Specification

Description	Specification
Logic Inputs	24V DC 5mA
Communication	RS232 – Onboard Display or Laptop Channel
Control Power Supply	18 to 34 VDC, 5A

Table 5: Protective Characteristics

Description	Specification
Undervoltage	300V DC
Overvoltage	850V DC
Overload	Motor thermal overload calculation: 150% current for 2 minutes 200% current for 20 seconds Current limit: Adjustable up to 200%
Thermal	Heatsink temperature alarm Heatsink temperature shutdown
Reverse Polarity	Not damaged by reverse connection of main DC supply
Power Loss	One second ride through on loss of main DC supply
Short Circuit	IGBT junction voltage monitoring (approx. 1500A) Line circuit fuse Armature circuit fuse Pre-charge circuit fuse
Motor Continuity	Motor Connections are verified at the start of each cycle

Table 6: EMC Specification

Description	Specification
Immunity	Designed to meet Requirements of EN50081-2
Emissions	Designed to meet Requirements of EN50081-2

1.3 Equipment List

Before accepting the A300, please ensure the contents of the package correspond with the items on the packing slip and the purchase order. Discrepancies should be discussed with the vendor of this product immediately for resolution. Also, please refer to the terms and conditions of sale.

Any damages due to shipping should be immediately claimed against the shipping carrier.

Each A300 is made up of the following modular sub-components inside the main enclosure. Table 7 and Figure 1, below, are given for reference purposes and outline the approximate location and underlying principal of each modular sub-component.

For terminal locations, see Figure 10: High Power Connection Schematic. For Mounting information, see sections 2.1 and 2.2 of this document.

Table 7: A300 Sub-Components

Item	Qty.	Part #	Description
1	1	A800969	Brake Chopper Module
2	1	A300201	Series Motor Controller Module
3	1	I9001-051	RFI/EMC Filter
4	2	I9001-050	Choke DC .5mh 150A
5	1	K9009-049	Main DC Contactor 1000V (28V DC Control) – CH 2120A7G01
6	1	F9002-080	15A/1000V Semiconductor Fuse
7	2	F9002-093	250A/700V Semiconductor Fuse

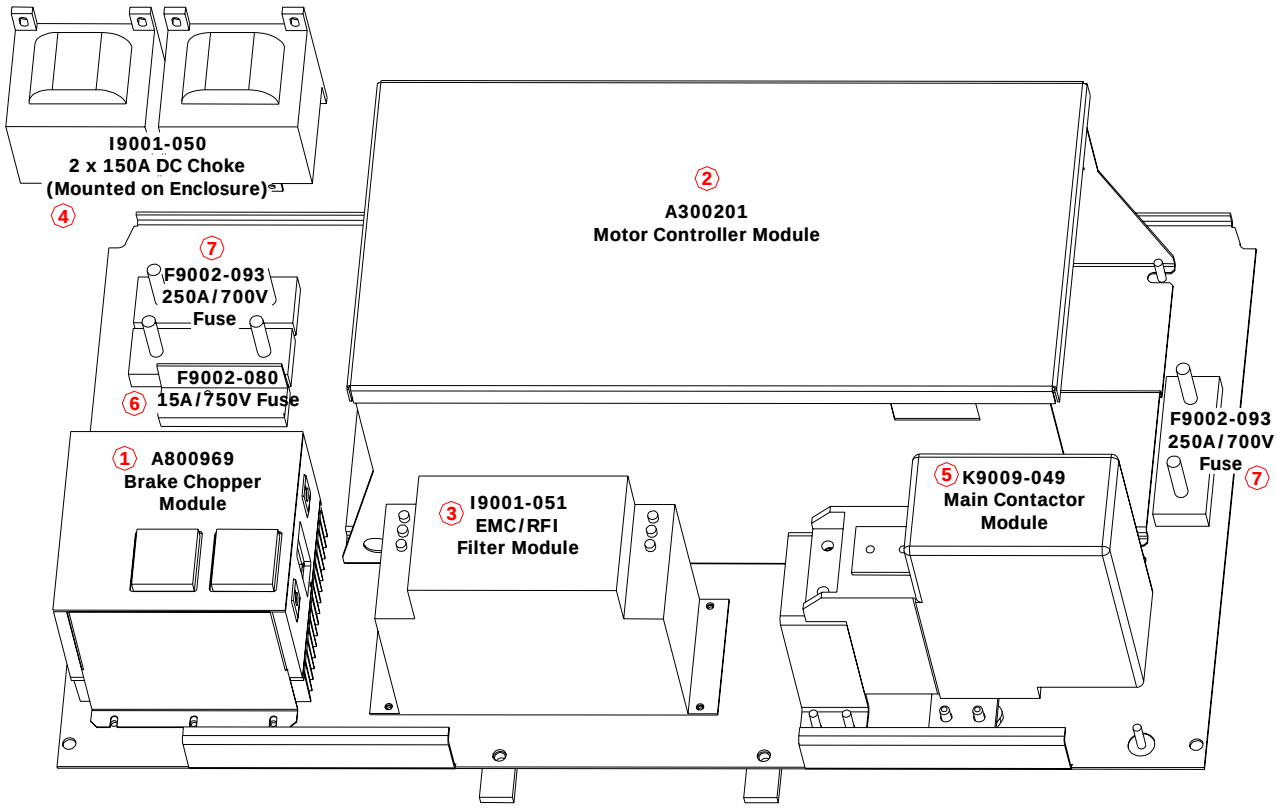


Figure 1: Main Components - Module Layout

1.4 Storage of the A300

In order to protect the equipment against humidity and contaminants during storage, the A300 unit should be fully enclosed. The shipping container, or plastic wrap is recommended for extended periods of storage. All units should be stored away from possible liquid contamination.

Failure to keep the unit dry and sealed can cause many of the components to deteriorate, which can become very dangerous under running conditions. Also, ensuring cleanliness of the unit will prolong the useable life of the unit.

The A300 has a maximum storage altitude of 3000m from Sea Level. It is important not to exceed this, as some internal components (i.e. capacitors) could leak, and cease to function correctly.

The acceptable temperature range for storage is between –40 and +70 °C.

1.5 Principal of operation

1.5.1 Solid-State Control

The A300 can control series field DC motors using power IGBTs (Insulated Gate Bipolar Transistors). These IGBTs are given controlled duty cycles which control the speed and torque of the drive motor(s). Controlling a motor in this fashion yields high efficiencies with percentages in

the mid to high 90's. Using the IGBTs, the A300 controls motor and braking functions with a PWM (pulse width modulation) signal. PWM is described in more detail in Section 1.5.4 of this document.

1.5.2 Four-Quadrant Operation and Dynamic Braking

The A300 is a four-quadrant motor controller, which allows it to be used to produce negative torque regardless of the drive motor's rotational direction. That said, this controller has the ability to provide dynamic braking, dissipating energy in outboard resistors as heath or returning the energy to the DC Supply.

1.5.3 Controller Configuration

The configuration of the A300 system is shown in Figure 2. The A300 System supplies armature current through T1 and T2 and field current through T3 and T4. This arrangement results in equal capabilities in either motor direction.

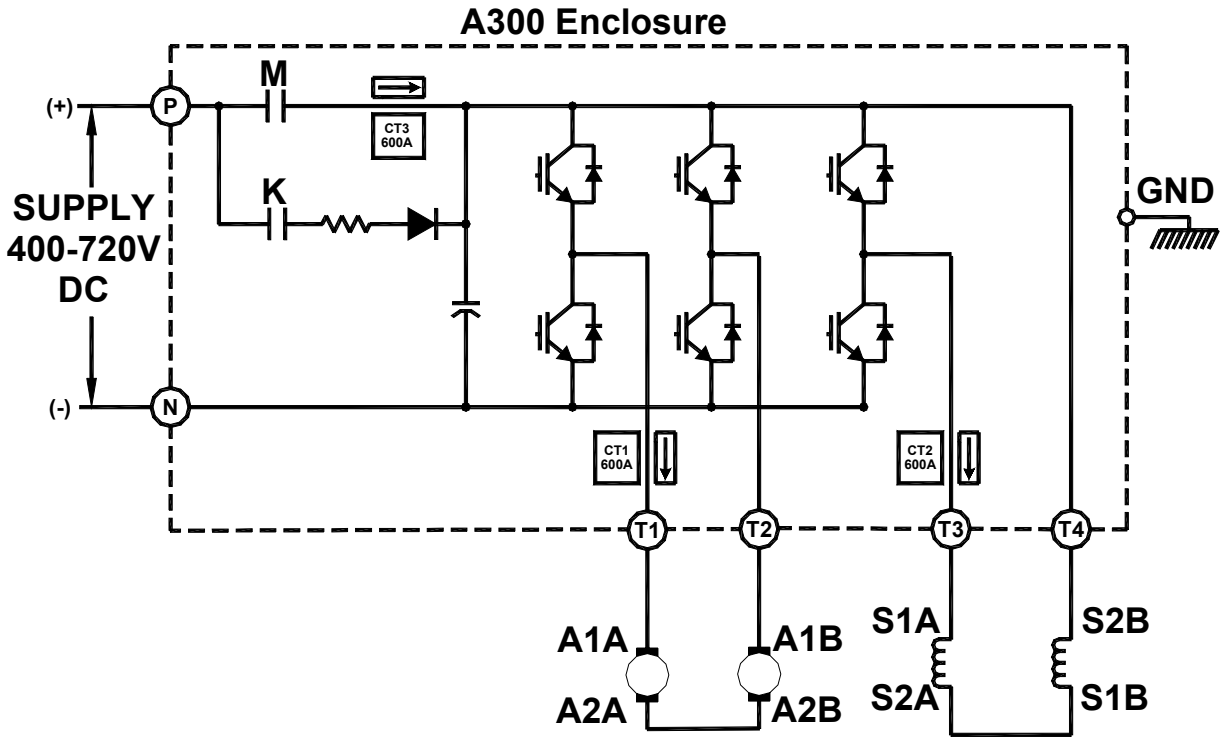


Figure 2: A300 Series Motor Controller Configuration

1.5.4 Pulse Width Modulation

A Pulse Width Modulation (PWM) signal is used to produce an output voltage on each terminal by controlling the duty cycles of each half bridge. The voltage across the motor winding is the difference between the two input voltages (T1-T2 Voltage in Figure 3, below) and may be made positive or negative as desired. The currents that flow have a small amount of high frequency ripple but are almost the same as if they had been derived from a smooth DC source.

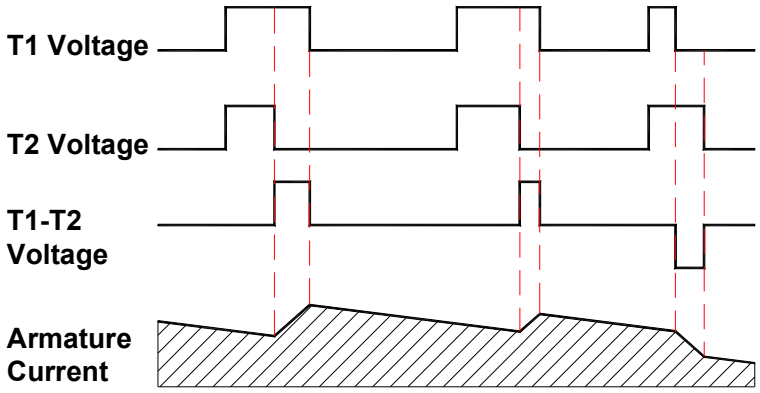


Figure 3: Pulse Width Modulation for Armature Current

Similarly, the field voltage is the difference between terminals T4 and T3. See Figure 4, below.

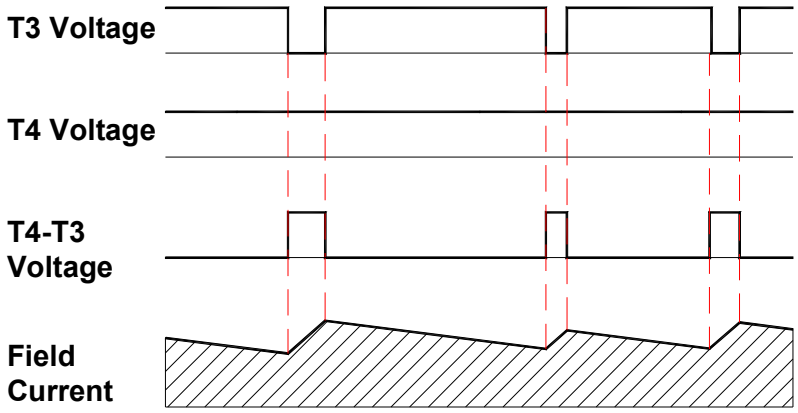


Figure 4: Pulse Width Modulation for Field Current

2 Installation

This section outlines the installation procedures required for safe use of the A300.

DANGER: UP TO 800V MAY EXIST IN THIS CONTROLLER. USE EXTREME CAUTION TO AVOID SHOCK. DISCONNECT INPUT POWER BEFORE WIRING OR SERVICING THE MOTOR.

2.1 Mounting and Mechanical Connections

Figure 5, below, shows a general dimensioned drawing of the A300 enclosure for mechanical mounting.

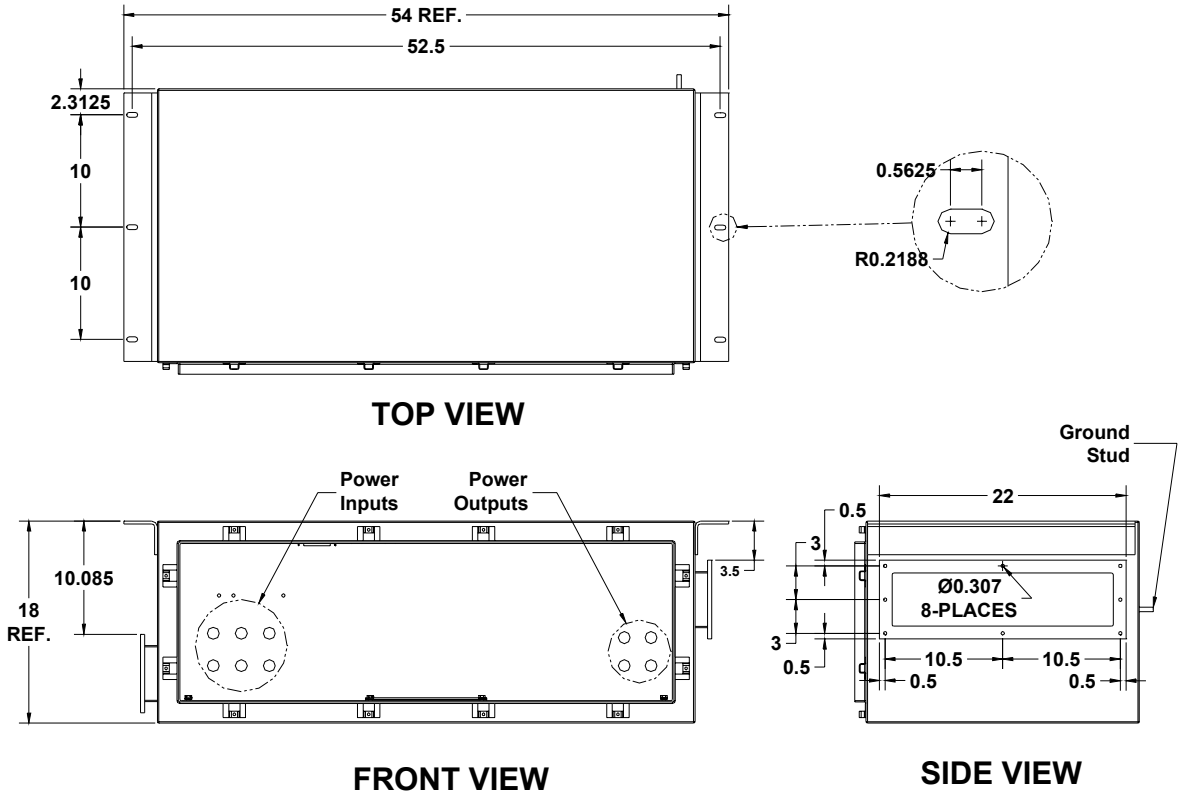


Figure 5: Mounting Connection Drawing

2.2 Control Connection and Harnesses

This section outlines the control wiring harnesses and connections. Cable and connector types are listed. For further installation information of these harnesses and connectors, please contact the vendor of this product.

2.2.1 Control Connector Pin-Outs

I/O Connector – CON1

The I/O connector is a Harting Box-mounted receptacle with 16 AWG male pins. The pin-out details are shown in Figure 6 and Table 8.

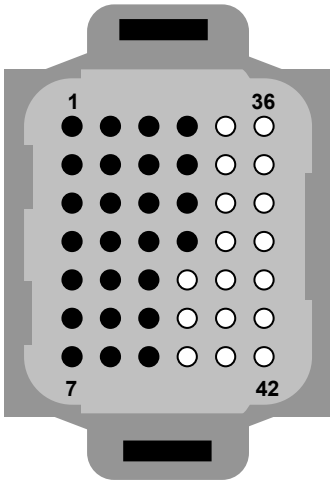


Figure 6: Appearance of CON1 Viewed From the Outside of the A300 System Enclosure

Table 8: CON1 – Main Control Connector

Pin	Signal Name	Description	Remark
1	BATT+	26V low-voltage supply positive	Consumption 40W typical, 60W maximum.
2	BATT-	26V low-voltage supply negative	
3	ENABLE	Controller enable signal: Low = controller inactive High = controller responds to drive and brake commands (See Note 1, below)	Compatible with 24V PLC logic outputs. 0V = low = inactive 24V = high = active
4	FWD	Drive forward signal: Low = controller does not drive forward. High = controller drives forward if brake release signal is high and drives reverse signal is low. (See Note 1, below)	
5	REV	Drive reverse signal: Low = controller does not drive reverse. High = controller drives reverse if brake release signal is high and drive forward signal is low. (See Note 1, below)	

Pin	Signal Name	Description	Remark
6	BRAKE_RELEASE	Brake release signal: Low = controller decelerates to stop High = controller responds to forward or reverse commands. (See Note 1, below)	
7	CODE1	Gray code traction level input 1 (See Note 2, below)	
8	CODE2	Gray code traction level input 2 (See Note 2, below)	
9	CODE3	Gray code traction level input 3 (See Note 2, below)	
10	REGEN_ENABLE	Regen enable input: Low = controller not permitted to return current to supply network. High = controller permitted to return current to supply network.	
11	RESET	Controller reset input: Low = controller reset not active High = controller reset active (See Note 3, below)	
12	SLIP_SPIN_ENABLE	Slip/spin detector enable: Low = slip/spin conditions ignored High = slip/spin conditions detected and recovery action applied	
13	FAULT	Controller fault indication: Low = fault or propulsion unit not ready. High = propulsion unit ready and no fault	Compatible with 24V PLC inputs. 0V = low = inactive 24V = high = active
14	SLIP/SPIN	Slip/spin indication: Low = slip spin not detected High = slip/spin condition detected (See Note 4, below)	
15	SPEED	Buffered speed detector signal: 0/+24V square wave output 9Hz per mph.	
16	BRAKE_SYNC	Brake chopper synchronization signal: Bi-directional 24V logic signal. Low = brake chopper off. High = brake chopper on.	Links to opposite end controller to balance brake resistor loads.
17	FLASH_ENABLE	Flash download enable: Low = normal operation High = select flash download on next controller reset	24V signal. Temporary use for software installation.
18	RS232_TX	Multi-function serial data lines	Use for software installation or data logging.
19	RS232_RX		
20	DISPLAY +5V	Monitor display/keypad 5V supply.	Temporary connection to monitoring and programming unit.
21	DISPLAY RESET	Monitor display/keypad reset signal.	
22	DISPLAY TX	Data to monitor display/keypad.	
23	DISPLAY RX	Data from monitor display/keypad.	
24	DISPLAY 0V	Monitor display/keypad ground.	
25	SHIELD	Connection for cable shield drain wire.	

Note 1: Truth table for ENABLE, BRAKE_RELEASE, FWD and REV inputs

ENABLE	BRAKE RELEASE	FWD	REV	CONTROLLER REPSONSE
0	X	X	X	Coast
1	0	X	X	Brake to standstill
1	1	0	0	Coast
1	1	0	1	Drive in reverse direction*
1	1	1	0	Drive in forward direction*
1	1	1	1	Coast

* Forward direction is defined as that for which terminal T1 of the controller becomes positive with respect to T2. Direction of tractive effort may be reversed by motor connections or gearing.

Note 2: Truth table for Gray code traction level inputs:

CODE 1	CODE 2	CODE 3	CONTROLLER RESPONSE
0	0	0	Run at Creep Speed
1	0	0	Drive or brake level 1
1	1	0	Drive or brake level 2
0	1	0	Drive or brake level 3
0	1	1	Drive or brake level 4
1	1	1	Drive or brake level 5
1	0	1	Drive or brake level 6
1	0	0	Drive or brake level 7

Note 3: Reset Signals

- A momentarily high reset signal can be used to re-initialize the controller to power on state.
- Reset signal must be released (low) for controller to operate normally.
- The reset signal must be manually accessible in order to execute the flash download procedure.

Note 4: Slip/Spin Indication

The slip/spin indication remains active for two seconds following detection of a slip/spin condition or will remain active as long as the condition exists.

Speed Sensor Connectors – CN2 and CN3

The speed sensor connector is a 5-way MIL-C-5015 wall mount receptacle, with 16 AWG female sockets using 22 AWG wire. CN2 is the active speed sensor input. The speed sensor from either axle may be connected to CN2. CN3 is not wired internally to the controller input and serves only as a termination point for the spare speed sensor signal. Figure 7, Figure 8, and Table 9 describes the signal for each pin.

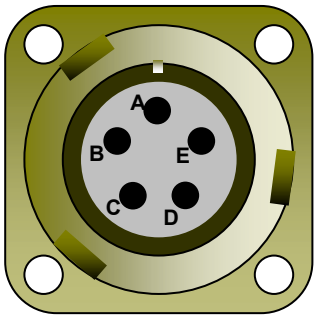


Figure 7: Appearance of CN2 and CN3 viewed from the outside of the enclosure

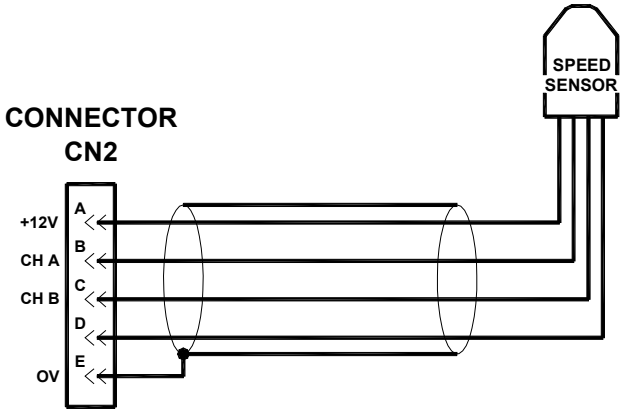


Figure 8: Speed Sensor Connections

Table 9: CN2 – Speed Sensor Connectors

Pin	Signal Name	Description	Remark
A	+15V	15V speed sensor supply	Protected by 0.5A self-resetting PTC fuse.
B	CH A	Speed sensor channel A	Open-collector outputs.
C	CH B	Speed sensor channel B	
D	0V	Speed sensor ground	
E	SHIELD	Speed sensor cable shield	Connect to drain wire of cable shield.

2.2.2 Control Wiring Harnesses

Figure 9 outlines the connections required for control of the A300. The cable connector CON1 is a Harting style with 16 AWG female crimped pins. The speed sensor cable connector (CN2) requires a 5-way MIL-C-5015 in-line receptacle, with 16 AWG male sockets.

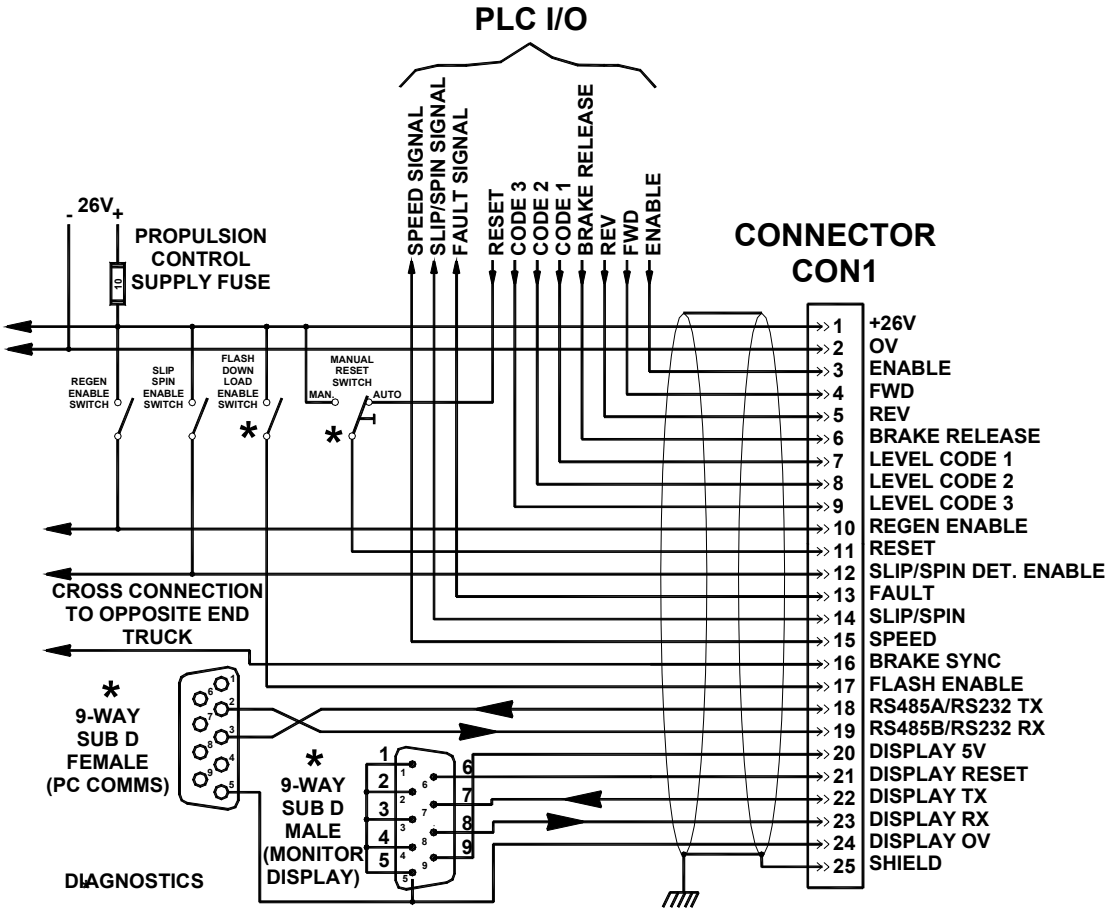


Figure 9: I/O Control Connections

2.3 High Power Connections

Please refer to Figure 1: Main Components - Module Layout on page 11 for the physical locations of each module. The full power schematic, with cable number labels, is shown in Figure 10.

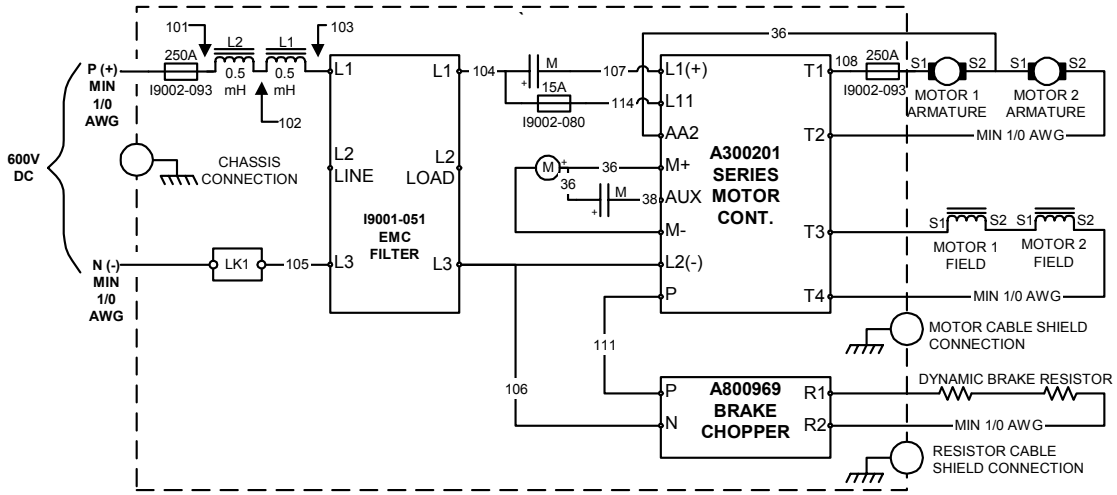


Figure 10: High Power Connection Schematic

3 Operation

This chapter describes how to verify the correct operation of an A300 unit, how to access monitoring information using the LCD module and how to carry out parameter adjustments if these are necessary.

3.1 Start-Up and Commissioning

A digital display module may be connected to the serial port for the purpose of monitoring functions during the commissioning process. This module is powered from the serial port connector. The display becomes active when the 26V control supply is connected to the A300.

3.1.1 Digital Display and Keypad Navigation

This display is software specific and can be attained using Saminco Reference Part: MA2263 – Display Board with Keypad. There is a 2-line LCD to display information and four pushbuttons to control the display and carry out adjustments.

Figure 11, Figure 12 and Table 10, below, shows the appearance and function of the LCD module and buttons. The menu structure is outlined in Figure 13.

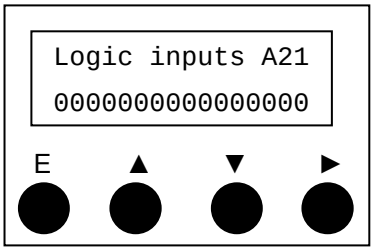


Figure 11: Digital Display

Figure 12: Digital Display Module

Table 10: Keypad Button Descriptions

Key Symbol	Key Name	Description
E	ENTER	Use this key to accept or select the current entry.
▲	UP	Increment to the next parameter or menu item. If at the last parameter or menu item, it will move back to the first.
▼	DOWN	Increment to the previous parameter or menu item. If at the first parameter or menu item, it will move back to the last.
►	RIGHT	This key is used to select the menu to be displayed.

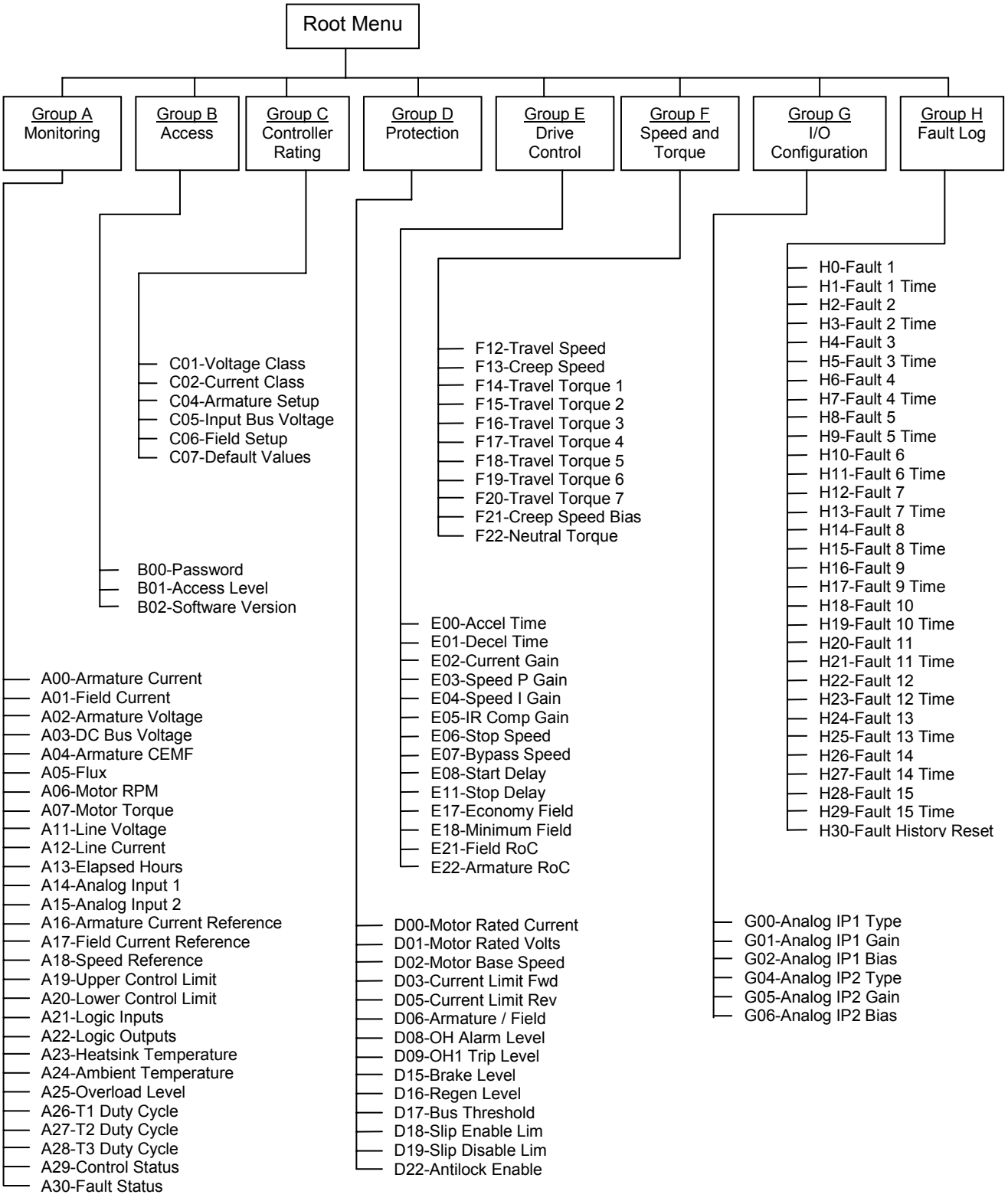


Figure 13: Menu Map

3.1.2 Start Up Procedure

1. Attach the LCD module to the remote serial port connector.
2. Confirm that all of the control inputs are in the inactive state, equivalent to no direction selected and the drivers control in the COAST position and regenerative braking disabled.
3. Apply a control supply voltage of between 16V and 30V DC to the A300 propulsion unit. The supply must have a peak output capability of 10A.
4. Confirm that the LCD initially displays “Brookville”/”Initialization” and changes after approximately 10 seconds to “Brookville”/”Streetcar”. If the display continues to show the “Initialization” message it is not receiving data from the main propulsion unit. Refer to section 7, Diagnostics and Fault Finding if this cannot be corrected either by momentarily applying the RESET switch or by cycling the control supply power.
5. Confirm that the fan on the motor control module starts when the RESET switch is applied and held. Confirm that the fan stops after the RESET switch is released. (The heatsink temperature must be below 50 deg C (122 deg F) for the fan to turn off.)
6. Use the ► key of the LCD module to select the A menu. Use the ▲ key to select A21 “Logic Inputs” Confirm that the value indicated is 00000000 00000000.
7. Operate the auxiliary contacts of the line contactor by hand. Confirm that the value of A21 changes to 00000001 00000000.
8. Confirm operation of the traction command inputs:

Enable	A21 = 00000000 00000001
Forward	A21 = 00000000 00000010
Reverse	A21 = 00000000 00000100
Traction level code 1	A21 = 00000000 00001000
Traction level code 2	A21 = 00000000 00010000
Traction level code 3	A21 = 00000000 00100000
Brake Release	A21 = 00000000 01000000
Regen Enable	A21 = 00000000 10000000

9. Confirm that the following parameters in the A menu are as shown in Table 11:

Table 11: Startup Requirements

A02	Armature Voltage	Less than 5V
A03	DC Bus Voltage	Less than 20V
A11	Line Voltage	Less than 20V
A23	Heatsink Temperature	Approximate actual value
A30	Fault Status	No Fault
A31	Sequence Status	Initialization

10. Connect line supply. Confirm that A03 and A11 both indicate values approximately the same as the line voltage.
11. Briefly apply a traction command. Confirm that the vehicle jogs in the correct direction.
12. Select the opposite direction. Confirm that the vehicle jogs in the correct direction.
13. Accelerate the vehicle to approximately 10 mph and apply a brake command. Confirm that the vehicle brakes electrically and that A03 is between 700V and 720V during deceleration.

14. Select regenerative braking. Accelerate the vehicle to approximately 10 mph and apply a brake command. Confirm that the vehicle brakes electrically and that A12 (Line Current) shows a negative value during deceleration.
15. Enable Slip/Spin detection. Run the vehicle at an approximately constant speed of 20 mph. Confirm that A15 (Analog Input 2 – Slip/spin signal) does not exceed 5%.

3.1.3 Digital Display Menu Tables

This section outlines the functions of each parameter in the display menu. All parameters are pre-set at the factory and should not be modified unless specified by Saminco.

Group A – Monitoring

Table 12: Group A – Monitoring

Parameter No.	Parameter Name	Function	Unit
Motor Current and Voltage			
A00	Armature Current	Displays the value of motor armature current derived from controller terminal T1 current measurement.	0.1A
A01	Field Current	Displays the value of motor field current derived from controller terminal T3 measurement.	0.1A
A02	Armature Voltage	Displays the value of the armature voltage measurement derived from controller terminals T1 and T2.	0.1V
A03	DC Bus Voltage	Displays the voltage on the controller DC bus capacitors	0.1V
Motor Speed and Torque Calculation			
A04	Armature CEMF	Displays the motor counter EMF as a percentage of the motor rated voltage.	0.1%
A05	Flux	Calculated motor flux as percentage of the full-field value.	0.1%
A06	Motor RPM	Calculated motor speed in RPM	1 RPM
A07	Motor Torque	Displays the calculated motor torque as a percentage.	0.1%
A11	Line Voltage	Displays the voltage at the line side of the line contactor.	0.1V
A12	Line Current	Displays the input current to the propulsion unit as a percentage of the motor rated current.	0.1%
Power, Energy and Operation Cycles			
A13	Elapsed Hours	Accumulated time controller is enabled.	1 hr
Analog Input Status			
A14	Analog Input 1	Displays the % full scale of analog input 1.	0.1%
A15	Analog Input 2	Displays the % full scale of analog input 2.	0.1%
Current and Speed			
A16	Armature Current Reference	Displays the armature calculated current reference as a percentage of the motor rated current.	0.1%
A17	Field Current Reference	Displays the field calculated current reference as a percentage of the motor rated current.	0.1%
A18	Speed Reference	Displays the calculated speed reference after acceleration and deceleration control as a percentage of the motor rated speed at full load.	0.1%

Parameter No.	Parameter Name	Function	Unit
A19	Upper Control Limit	Displays the forward current limit applied to the speed controller.	0.1%
A20	Lower Control Limit	Displays the reverse current limit applied to the speed controller.	0.1%
Logic I/O Status			
A21	Logic Inputs	Displays the status of the logic inputs	16 bit
A22	Logic Outputs	Displays the status of the logic outputs	16 bit
Controller Status			
A23	Heatsink Temperature	Displays the temperature of the semiconductor heatsink.	0.1°C
A24	Ambient Temperature	Displays the ambient temperature inside the A300 Enclosure (Not Used at this Time)	N/A
A25	Overload Level	Displays the accumulated value of armature current overload above 110%.	0 or 1
A26	T1 Duty Cycle	Displays the PWM duty cycle at terminal T1	0.1%
A27	T2 Duty Cycle	Displays the PWM duty cycle at terminal T2	0.1%
A28	T3 Duty Cycle	Displays the PWM duty cycle at terminal T3	0.1%
A29	Control Status	Displays control status register flags	16 bit
A30	Fault Status*	Displays the active trip before reset 0 = No Fault 1 = Control Supply Under Voltage (CUV) 2 = Under Voltage (UV1) 3 = Heatsink Over-temp. Alarm (OH1) 4 = Heatsink Over-temp. Trip (OT1) 5 = Short Circuit (SC) (IGBT Driver Module) 6 = Over Voltage Trip (OV) 7 = External Fault 8 = Parameter Exceeds Rating (PER) 9 = Not Implemented 10 = Not Implemented 11 = Not Implemented 12 = Not Implemented 13 = Motor Overload (MOL) 14 = Not Implemented 15 = Change of Configuration (COC) Locks out drive immediate operation if configuration (C00) is changed.	N/A

*Also, see Table 26: Fault Codes and Corrective Action in Section 7.3:Troubleshooting.

Group B – Access

Table 13: Group B – Access

Parameter No.	Parameter Name	FACTORY DEFAULT	Range	Access Level*
B00	Password	0	0 65535 0: (Monitor Only) 212: (Plant User)	0
B01	Access Level	Monitor	0: Monitor Only 1: Plant User 2: Engineer	0
B02	Software Version	N/A	N/A	0

*** THIS PRODUCT REQUIRES PASSWORDS TO MAKE PARAMETER CHANGES. IT IS THE RESPONSIBILITY OF THE PURCHASER/USER TO SECURE THESE PASSWORDS AND MAKE THEM AVAILABLE ONLY TO QUALIFIED, TRAINED PERSONNEL. IMPROPER PARAMETER SET UP CAN DAMAGE EQUIPMENT AND CAN POSE A HAZARD TO PERSONNEL.**

GROUP C – Controller Rating Set Up

Table 14: Group C – Controller Rating Set Up

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
C01	Voltage Class	1 400/720V	400V	720V	1	-
C02	Current Class	N4: 200A	200A	200A	1	-
C04	Armature Setup	Int. CT	-	-	-	-
C05	Input Bus Voltage	600	200	700	1V	2
C06	Field Setup	Int. CT	-	-	-	-
C07	Default Values	No Action			1	2

C01 – Voltage Class (Set By Manufacturer)

This parameter defines the measurement scaling for the DC bus voltage and the motor armature voltage and must match the nameplate rating of the controller and is not modifiable by the customer.

C02 – Current Class (Set By Manufacturer)

This parameter defines the measurement scaling for motor armature current and motor field current. It must match the nameplate rating of the controller and is not modifiable by the customer.

C04 – Armature Setup (Set By Manufacturer)

This parameter defines the total number of times the output current passes through the eye of the current sensors including the existing bus bar and is not modifiable by the customer.

C05 – Input Voltage

Parameter specifies the nominal bus voltage of the DC supply system. It also sets the under voltage trip point (50%) and the Over voltage trip point (140%). If the input voltage is set higher than 600V the over-voltage trip point is limited to 840V. Between 710V and 840V, the dump resistor PWM signal goes from 0% to 100%.

C06 – Field Setup (Set By Manufacturer)

This parameter defines the type of motor. It must match the nameplate rating and is not modifiable by the customer.

C07 – Default Values

Provides the ability to store and restore the user parameter set up into the e-prom of the drive. Also provides the ability to load factory default settings. Access to store and restore is provided by the user or engineer password level.

To store the user settings select Store User Setting after all of the parameters are set and checked for accuracy.

To restore the user settings enter password and select Restore User Setting.

To restore the factory settings select the Restore Factory Setting. It will be necessary to reset the parameters for proper operation for the specific drive and motor used since the default settings are not drive specific as the user settings are.

The default settings will not become effective until the controller is powered down or reset.

Warning: Before installing a control board, whether from another drive or from inventory, follow the proper set-up procedure. Incorrect drive set-up can cause equipment damage or personnel injury.

GROUP D – Protection

Table 15: Group D – Protection

Parameter No.	Parameter Name	User Setting	Minimum	Maximum	Unit	Access Level
D00	Motor Rated Current	170	1	2000	1A	2
D01	Motor Rated Volts	600	200	700	1V	2
D02	Motor Base Speed	1600	0	5000	1 RPM	2
D03	Current Limit Fwd	100%	50	200	0.1%	2
D05	Current Limit Rev	100%	50	200	0.1%	2
D06	Armature / Field	2.0	1.1	3.0	0.1	2
D08	OH Alarm Level	85 C	70	85	1 C	2
D09	OH1 Trip Level	105 C	85	115	1 C	2
D15	Brake Level	705	600	800	1V	2
D16	Regen Level	10	0.0	100.0	0.1%	2
D17	Bus Threshold	50	0	300	1V	2
D18	Slip Enable Lim	8.0	0.0	50.0	0.1%	2
D19	Slip Disable Lim	6.0	0.0	50.0	0.1%	2
D22	Antilock Enable	700	0	32767	1	2

D00 – Motor Rated Current

This parameter must be set to the full load motor nameplate rating multiplied by the number of parallel motor paths per controller output.

D01 – Motor Rated Voltage

This parameter is normally set to the motor nameplate voltage rating multiplied by the number of motors connected in series between the controller outputs.

This parameter is important to obtain the proper speed control from the drive as it influences the CEMF calculation.

D02 – Motor Base Speed

Parameter to be set to the motor nameplate rated RPM. This parameter is used to calculate the A06 Motor RPM display value. If this value is incorrect the display reading will not be accurate but the drive will operate properly.

D05 – Current Limit Forward and Current Limit Reverse

These parameters set the maximum current limit in the forward direction and reverse direction during acceleration and deceleration.

D06 – Armature / Field

This parameter limits the maximum ratio of armature current to field current in order to ensure that the commutation capability of the motor is not exceeded at high speeds. Operation of the motor above its base speed requires the field to be weakened in order to maintain the armature voltage at approximately the same level as the supply voltage. The controller weakens the field automatically when speeds in excess of the base speed are required.

D08 – OH Alarm Level

This parameter sets the temperature level at which the semiconductor heat sink provides a warning of possible shutdown. When this temperature level is reached the drive will cut back the current and allow only 150% maximum current for the one minute cycle and not the 200% for three seconds. The level is adjustable from 70 to 85 ºC.

D09 – OH1 Trip Level

This parameter sets the heatsink temperature where the drive will fault and shut down until the heatsink cools below the set level. The level is adjustable from 85 to 115 ºC.

D15 – Brake Level

This parameter controls the analog brake level signal applied to the dynamic brake chopper. This determines the DC bus voltage level at which the brake chopper turns on. The voltage impressed upon the supply network during regenerative braking is limited to this level provided the impedance of the brake resistor is low enough to absorb the difference between the total DC bus current and the current that can be absorbed by the supply. The brake level must not be set so low as to cause the brake chopper to become active normal line voltage conditions or become active when nearby vehicles are regenerating.

D16 – Regen Level

When regenerative braking is not enabled the line contactor in the propulsion unit is opened when the reverse line current exceeds this parameter. Current is then diverted to the on-board brake chopper. Regen Level is typically set at 10%. Increasing this level results in more current returned to the line before the contactor opens. Reducing this level may result in unnecessarily frequent cycles of the contactor.

D17 – Bus Threshold

This parameter controls the point at which the line contactor returns to the closed position during non-regenerative braking. The Bus Threshold is the amount by which the DC bus voltage must fall below the line voltage before re-closure is initiated. Bus Threshold is typically set at 50V. Increasing this level causes a larger inrush current and delays the transition to the driving mode. Reducing this level may result in unnecessarily frequent cycles of the contactor.

D18 – Slip Enable Lim

This parameter sets the amount of wheel slip that must be detected before the anti-slip action is initiated. Slip detection is based upon measurement of the difference in armature voltage between the two series-connected armatures on the same truck. The following formula should be used:

Slip threshold (mph) = 0.0167 x (Slip Enable Lim) x (mph at motor base speed)

Example: If the vehicle speed is 17mph when the motor is at its base speed and Slip Enable Lim is set to 15%, anti-slip action will occur when the wheel rim velocity difference is 4.25mph.

Note that differences in wheel diameter on the same truck will cause the wheel slip detection to be more sensitive in one direction and less sensitive in the other.

D19 – Slip Disable Lim

This parameter sets the level of wheel slip at which normal traction or braking is resumed after anti-slip action has been taken. The following formula should be used:

Slip recovery threshold(mph) = 0.0167 x (Slip Disable Lim) x (mph at motor base speed)

Example: If the vehicle speed is 17mph when the motor is at its base speed and Slip Disable Lim is set to 5%, recovery from anti-slip action will occur when the wheel rim velocity difference is 1.42mph.

Note that differences in wheel diameter on the same truck will cause the wheel slip detection to be more sensitive in one direction and less sensitive in the other.

Note also that if there is a large difference in wheel diameters and Slip Disable Lim is set too low it is possible that recovery is delayed indefinitely resulting in loss of traction or electric braking until the vehicle is brought to a lower speed by mechanical brakes.

D22 – Antilock Enable

This parameter sets the deceleration rate that will trigger the slip/spin anti-slip action in the event that both wheels of a truck slip without causing a significant difference in speed between the wheels.

Deceleration trigger level (mph/sec) = 0.00117 x (Antilock Enable) x (mph at motor base speed)

Example: If the vehicle speed is 17mph when the motor is at its base speed and Antilock Enable is set to 500, anti-slip action will occur if the rate of deceleration exceeds 9.95 mph/sec.

GROUP E – Drive Control Set Up

Table 16: Group E – Drive Control Set Up

Parameter No.	Parameter Name	USER SETTING	Min	Max	Unit	Access Level
E00	Accel Time	0.0 sec	0.0	20.0	0.1 sec	1
E01	Decel Time	0.0 sec	0.2	20.0	0.1 sec	1
E02	Current Gain	0.3	0.1	2.0	0.1	2
E03	Speed P Gain	10.0	1.0	10.0	0.1	2
E04	Speed I Gain	0.02	0.02	0.20	0.01	2
E05	IR Comp Gain	0.00	0.00	0.20	0.01	2
E06	Stop Speed	0.0%	0.0	400.0	0.1%	2
E07	Bypass Speed	0.0%	0	25	0.1%	2
E08	Start Delay	100 ms	50	2000	1 ms	2
E11	Stop Delay	0ms	0	2500	1 ms	2
E17	Economy Field	50%	50	100	0.1%	2
E18	Minimum Field	40%	25	100	0.1%	2
E21	Field RoC	2FFF	0	FFFF	1(hex)	2
E22	Armature RoC	FFFF	0	FFFF	1(hex)	2

E00 and E01 – Accel Time and Decel Time

These parameters set the minimum times for a speed increase or decrease of a magnitude equal to the base speed of the motor. If either parameter is set to zero the acceleration control is disabled.

E02 – Current Gain

This parameter specifies the scaling factor gain for the armature and field control loops. This parameter simultaneously adjusts the proportional and integral gain for both armature and field. This parameter is set to match the inductance of the traction motor.

E03 – Speed P Gain

This parameter sets the amount of proportional action for the speed loop. This has an effect on the stability of braking performance when operating close to zero speed. The Speed P Gain is set to a value of 10. Reducing the Speed P Gain will give smoother running if the system is to be tested off the vehicle or with the wheels lifted clear of the rails but under actual driving conditions.

E04 – Speed I Gain

This parameter sets the amount of integral action for the speed loop. The presence of some integral gain ensures that the braking effort is maintained down to a very low speed that is within the normal range at which the mechanical brakes are set.

E05 – IR Comp Gain

The speed loop IR compensation gain tightens up the speed regulation from no load to full load. This parameter affects the dynamic response of the speed loop. IR compensation should be set to zero whenever fast speed loops are necessary. IR compensation is set to zero in this application.

E06 – Stop Speed

This parameter sets the speed value that will initiate the stop sequence in the software. When the controlled speed reference (A18) reaches this value the DB contactor is de-energized and the DB Delay Time (E08) begins. The Stop Speed is set to zero in this application.

E07 – Bypass Speed

This parameter defines an instant speed reference to the drive speed control loop without applying the acceleration time ramp. Setting this parameter permits a faster response on starting but will also increase the shock load to the mechanical system. Care should be taken to make sure that the value does not introduce damaging shock loads to the mechanical drive train. The Stop Speed is set to zero in this application.

E08 – Start Delay

This parameter allows time for the main contactor to close before the control loops activate and accelerate the motor. In this application an auxiliary contact delays the activation of the controller until the main poles are closed.

E11 – Stop Delay

This parameter allows time for the main contactor to open before the control loops de-activate and stop the motor.

E17 – Economy Field

This parameter determines the light-load field current and may be used to minimize motor heating when full accelerating or braking torque is not needed. Increasing the economy field level allows the full motor torque to be produced more quickly.

E18 – Minimum Field

This parameter establishes the minimum field reference. This places an upper limit on the speed of the motor. The maximum speed is almost inversely proportional to the value of minimum field. A value of 40% allows approximately twice base speed to be achieved when the line voltage is at 600V.

E21 – Field RoC

This parameter controls the maximum rate-of-change of field current. This is a hexadecimal value.

The maximum value of FFFFH corresponds to a 400% change per second. This is the recommended value.

E22 – Armature RoC

This parameter controls the maximum rate-of-change of armature current. This is a hexadecimal value. The maximum value of FFFFH corresponds to a 400% change per second. The recommended value is 2FFFH. This allows 75% change per second.

GROUP F – Speed and Torque Settings

Table 17: Group F – Speed and Torque Settings

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
F12	Travel Speed	200%	0	300	0.1%	1
F13	Creep Speed	5.5%	0	10	0.1%	1
F14	Travel Torque 1	30%	0	200	0.1%	1
F15	Travel Torque 2	60%	0	200	0.1%	1
F16	Travel Torque 3	75%	0	200	0.1%	1
F17	Travel Torque 4	90%	0	200	0.1%	1
F18	Travel Torque 5	105%	0	200	0.1%	1
F19	Travel Torque 6	120%	0	200	0.1%	1
F20	Travel Torque 7	140%	0	200	0.1%	1
F21	Creep Speed Bias	0%	-2	+2	0.1%	1
F22	Neutral Torque	0.1%	0	200	0.1%	1

F12 – Travel Speed

This parameter defines the maximum operating speed. Setting is in percent of motor base speed.

F13 – Creep Speed

This parameter defines the speed at which the vehicle runs when the creep speed mode is selected by applying a forward or reverse command to the controller while all three traction level code inputs are zero. The setting is in percent of motor base speed.

F21 – Creep Speed Bias

This parameter is used to trim out the analog offset in the armature voltage measurement circuit in order to obtain exactly equal creep speeds in both directions. A positive creep speed bias increases the creep speed in the forward direction and decreases the creep speed in the reverse direction. The correct value of creep speed bias can be determined by setting the creep speed, F13, to zero and adjusting F21 to hold the vehicle at standstill during creep speed operation.

F14 to F20 and F21 – Travel Torque 1 through 7

These parameters set up the acceleration and braking levels based upon the displacement of the driver's control. Various levels of torque can be set for each of the switch positions.

F22 – Neutral Torque

Neutral Torque used to apply a small stopping torque when the driver selects the coast position. The purpose of this is to ensure that the vehicle speed will not remain the same or slowly increase if the controller is still enabled while the coast position has been selected.

GROUP G – I/O Configuration

Table 18: Group G – I/O Configuration

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
G00	Analog IP1 Type	± 10 V	N/A		1	2
G01	Analog IP1 Gain	1.67	0.00	10.00	0.01	2

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
G02	Analog IP1 Bias	0.0%	-10	+10	0.1%	2
G04	Analog IP2 Type	0/+10 V	N/A		1	2
G05	Analog IP2 Gain	1.00	0.00	10.00	0.01	2
G06	Analog IP2 Bias	0.0%	-10	+10	0.1%	2

G00 and G04 – Analog IP1 and IP2 Type

These parameters define the signal format for the analog inputs. IP1 is a bipolar signal used for sensing line current and voltage across the line contactor and must be ±10V type. IP2 is a unipolar signal used for slip/spin measurement and must be 0..+10V type.

G01 and G05 – Analog IP1 and IP2 Gain

Set the input scaling gain factor for IP1 and IP2. IP1 must be set to 1.67 in order to correctly scale 600V line voltage to 100%. IP2 must be set to 1 in order to scale the slip/spin signal to a range of 100% for a 500V difference in armature voltages.

G02 and G06 – Analog IP1 and IP2 Bias

This parameter allows the input signal to be offset by plus or minus 10%. The bias compensates for signal variances. These parameters are set to zero in this application.

GROUP H – Fault Log

Table 19: Group H – Fault Log

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
H0	Fault 1	-	-	-	-	0
H1	Fault 1 Time	-	-	-	-	0
H2	Fault 2	-	-	-	-	0
H3	Fault 2 Time	-	-	-	-	0
H4	Fault 3	-	-	-	-	0
H5	Fault 3 Time	-	-	-	-	0
H6	Fault 4	-	-	-	-	0
H7	Fault 4 Time	-	-	-	-	0
H8	Fault 5	-	-	-	-	0
H9	Fault 5 Time	-	-	-	-	0
H10	Fault 6	-	-	-	-	0
H11	Fault 6 Time	-	-	-	-	0
H12	Fault 7	-	-	-	-	0
H13	Fault 7 Time	-	-	-	-	0
H14	Fault 8	-	-	-	-	0
H15	Fault 8 Time	-	-	-	-	0
H16	Fault 9	-	-	-	-	0
H17	Fault 9 Time	-	-	-	-	0
H18	Fault 10	-	-	-	-	0
H19	Fault 10 Time	-	-	-	-	0
H20	Fault 11	-	-	-	-	0
H21	Fault 11 Time	-	-	-	-	0

Parameter No.	Parameter Name	User Setting	Min	Max	Unit	Access Level
H22	Fault 12	-	-	-	-	0
H23	Fault 12 Time	-	-	-	-	0
H24	Fault 13	-	-	-	-	0
H25	Fault 13 Time	-	-	-	-	0
H26	Fault 14	-	-	-	-	0
H27	Fault 14 Time	-	-	-	-	0
H28	Fault 15	-	-	-	-	0
H29	Fault 15 Time	-	-	-	-	0
H30	Fault HistoryReset	-	-	-	-	0

4 Maintenance and Repair

4.1 Fuses (F9002-093 and F9002-080)

The A300 contains two main power fuses rated at 250A, 700V (F9002-093) and a fuse in the pre-charge circuit rated at 15A, 1000V (F9002-080). The fuses are high-speed semiconductor fuses with DC interrupting capability.

4.1.1 Testing

Before testing fuses ensure that:

- Main power has been switched off.
- Control power has been switched off.
- The filter capacitors have had sufficient time (5 minutes) to discharge to a very low residual voltage.

Test fuses with an ohmmeter, continuity tester or a digital multi-meter set to the diode test range.

A good fuse will always indicate a zero resistance path in both directions.

It is sometimes possible for a small residual voltage from the filter capacitors to produce a false indication of good continuity through the fuse. Reverse the leads of the instrument and confirm good continuity in both directions.

4.1.2 Removal and Replacement

1. Remove failed fuses by removing the nuts from the retaining studs of the fuse holder. Figure 14 shows the fuses in the A300 system – From Left to Right: F9002-093 and F9002-080
2. Withdraw lugs of attached cables if necessary.
3. Withdraw the fuse.
4. Check the tightness of the fuse holder mountings.
5. Install the replacement fuse. Ensure that attached cable connections are replaced at the same end of the fuse holder from which they were withdrawn.

Figure 14: Fuses in the A300 System

4.1.3 Specifications

Table 20: A300 System – Fuse Specifications

Fuse Location	Fuse Characteristics	Approved types
Line supply and armature (F9002-093)	High-speed semiconductor fuse 250A, 700V	GOULD SHAWMUT A70QS250-4
Pre-charge circuit (F9002-080)	High-speed semiconductor fuse 15A, 1000V	GOULD SHAWMUT A100P15-1

Written approval must be obtained from Saminco Inc. before alternative types are used for this application.

4.2 Line Filter Chokes (I9001-050)

Two identical inductors of 0.5mH each are connected in series to yield a total inductance of 1mH. See Figure 15.

Figure 15: Line Filter Choke

4.2.1 Inspection

Check the tightness of the mounting hardware.

Check the tightness of the connections. Do not re-tighten the connection screws without using a wrench on the back nut to restrain the movement of the connecting lug.

If a choke shows signs of overheating either as a result of sustained operation at very high currents or as a result of loose connections it should be replaced.

4.2.2 Removal and Replacement

1. Disconnect all power connections.
2. Disconnect choke connections.
3. Unplug control connections from motor control module.
4. Remove the retaining screws from the baseplate.
5. Withdraw the baseplate complete with attached components.
6. Disconnect the series link. Remove the mounting hardware and withdraw the component.
7. Fit and the replacement choke. Ensure mountings and connections are secure.
8. Reconnect the series link. Do not strain the connecting lugs when tightening.
9. Install the baseplate assembly. Replace the retaining screws.
10. Reconnect the choke connections.

4.2.3 Specifications

Table 21: Line Filter Specifications

Rating Description	Rating
Inductance	0.5mH
Current Rating	100A DC continuous

4.3 EMC Filter (I9001-051)

The EMC filter is a 3-phase high-attenuation filter. Two phases are used for the line supply and return paths. The third phase is not connected.

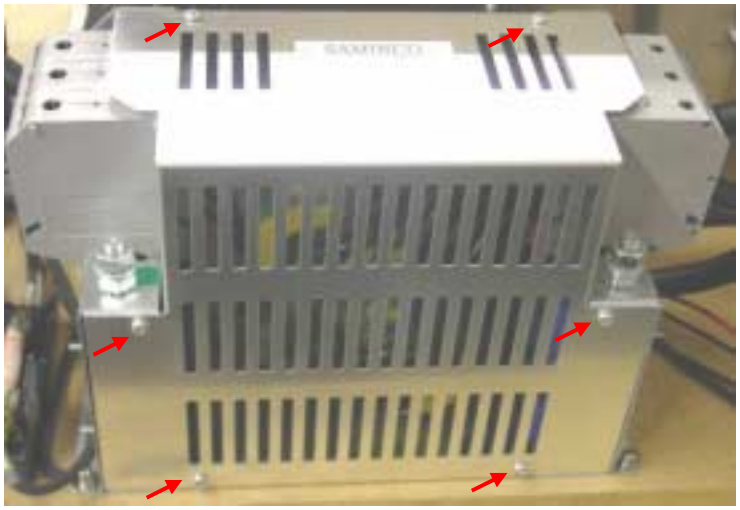


Figure 16: EMC Filter - I9001-051

4.3.1 Inspection

Remove the slotted front cover, which is secured by six screws shown in Figure 16. Figure 17 shows the EMC filter with the cover removed.

Check that the inductor cores and the two printed circuit boards are secure. Ensure the power connections are tight.

Replace the front cover.

The component should be replaced if any damage has occurred as a result of sustained overloading or loose connections.

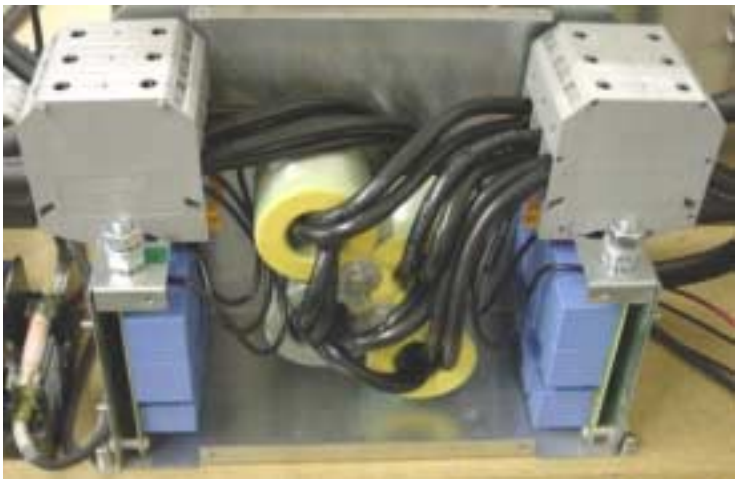


Figure 17: EMC Filter with Cover Removed

4.3.2 Removal and Replacement

1. Disconnect power cable from input and output.
2. Disconnect ground cable.
3. Remove the mounting hardware and withdraw the component.
4. Fit the new component. Ensure that the mountings are secure.
5. Reconnect ground and power cables. Ensure that connections are tight.

4.3.3 Specifications

This is an MTE 150CE5 150A, 600V 3-phase High-attenuation filter.

The printed circuit boards used in this filter must be coated with a conformal lacquer or an electrical insulating varnish suitable for printed circuit boards before the filter can be used in this application. Figure 18 shows the typical attenuation characteristic of this EMC filter.

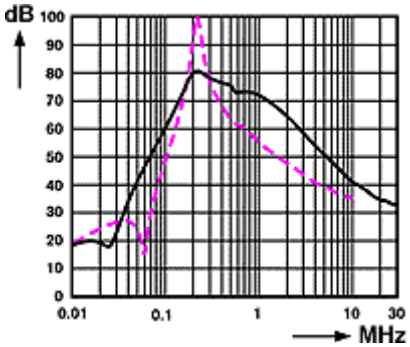


Figure 18: EMC Filter Attenuation Characteristic

4.4 Line Contactor (K9009-049)

The line contactor is a solenoid-operated switch rated at 1000V and 1000A. The design of the A300 control system is such that the power semiconductors normally control current and voltage before the contactor is operated (a picture of the line contactor is shown in Figure 19). The wear of the contact surfaces is therefore minimized and regular replacement of the tips will not be necessary.

Figure 19: Line Contactor

4.4.1 Inspection and Testing

The arc chute should be removed to inspect the condition of the contact tips, arcing horns and the mechanism – see Figure 20 and Figure 21. It is not necessary to remove the contactor from the equipment in order to carry out this procedure.

Figure 20: Arc Chute Retaining Screw

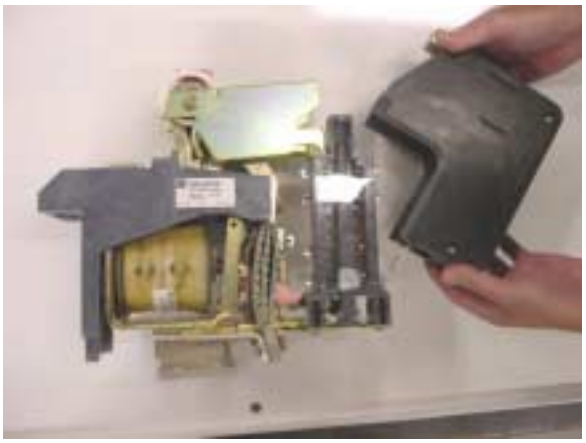


Figure 21: Removal of the Arc Chute

Inspection items:

1. Contact tips must not be excessively worn or burnt – See Figure 22.
2. Contact tips must have adequate surface in contact when they are closed and have adequate lift and wipe.
3. The leading center contact must be free to move against the pressure spring.
4. The arc chute must be free from cracks and large chips.
5. The arc chute material and the arcing horns must not be excessively burnt.
6. The arc chute connecting wire must be free from abrasion or cuts.
7. The auxiliary contacts must move freely – See Figure 23.
8. Ensure the armature gap (circled in Figure 23) is no less than 0.03 inches when contactor is depressed.

Figure 22: Contact tips and blowout poles

Figure 23: Checking Auxiliary Contact Operation

4.4.2 Removal and Replacement

1. Remove the arc chute.
2. Disconnect the coil and auxiliary contact connections.
3. Disconnect the line-side cables (#104) from the top terminals.
4. Disconnect the load-side cable (#105) from the bottom busbar.
5. Remove the remaining three nuts that secure the busbar to the stand-offs.

6. Unbolt the contactor body from the mounting bracket.
7. If replacing the contactor, unbolt and remove the bottom busbar from the contactor and attach to the replacement.
8. Follow the same sequence in reverse to re-install.
9. After installation, check that the connections to the coil and the auxiliary contacts are secure. If necessary, squeeze together the quick connect terminals or replace them to ensure that they have a firm grip on the tags.

4.4.3 Replacing Parts

Please refer to Table 30 in Appendix A: Parts List for a list of contactor replacement parts that can be ordered.

4.4.4 Specifications

Table 22: Line Contactor Specifications

Specification Description	Specification
Maximum Inline Voltage	1000 VDC
Continuous Current Rating	1250 A
Interrupt Current Rating	1250 A

4.5 Motor Control Module (A300201)

Figure 24 through Figure 27 shows several views of the A300 Motor Controller Module.

Figure 24: A300 Motor Controller Module

Figure 25: A300 Line-Side Terminals

Figure 26: A300 Load-Side Terminals

Figure 27: A300 Motor Controller with Top Cover Removed

4.5.1 Inspection and Testing

Ensure that the heatsink (see Figure 28) is not obstructed by accumulated dirt. Inserting a small brush between the fins and blowing with compressed air can remove dirt. Isopropyl alcohol may be used to remove greasy or sticky residues.

IMPORTANT: DO NOT USE WATER OR CHLORINATED SOLVENTS

Ensure that the fan (G9005-022) can rotate freely and that electrical connections and mounting hardware are secure.

Execution of the test procedure for the Series Motor Control module requires a complete test fixture with a motor load stand. If a module requires retesting or recalibration it should be returned to Saminco.

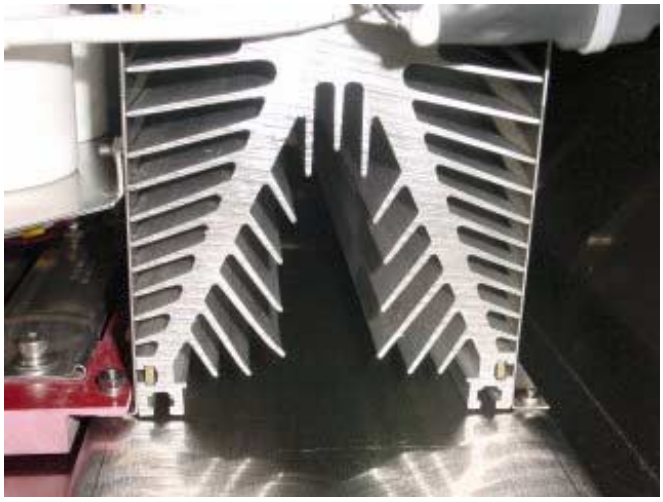


Figure 28: Y9004010 – A300 Motor Control Module Heat Sink

4.5.2 Removal and Replacement

1. Disconnect all external power connections from the propulsion module.
2. Remove the baseplate retaining screws.
3. Slide out the baseplate ensuring that the front edge is supported.
4. Disconnect power cables #106, #107, #108, #111, ans #114 – refer to Figure 10 for the connection schematic.
5. Disconnect control cables #36, #37 and #38.
6. Loosen the six cover retaining screws. Remove the cover.
7. Disconnect plugs from J15, J16, J18 and J19.
8. Remove the four fixing screws that secure the module to the baseplate. Withdraw the module.

The module may be installed by reversing these steps.

4.5.3 Replacing Parts

Fan Removal (A300303)

1. Unplug the 2-pin connector from J14 on the MA2287 gate drive board. Figure 29 shows the location of this connector.

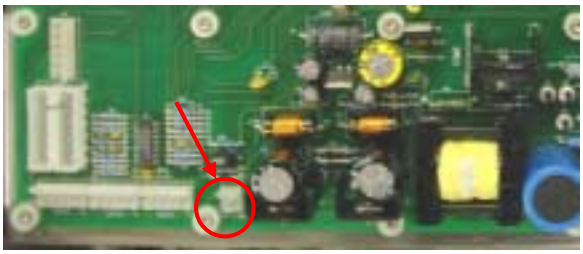


Figure 29: Location of J14 on MA2287

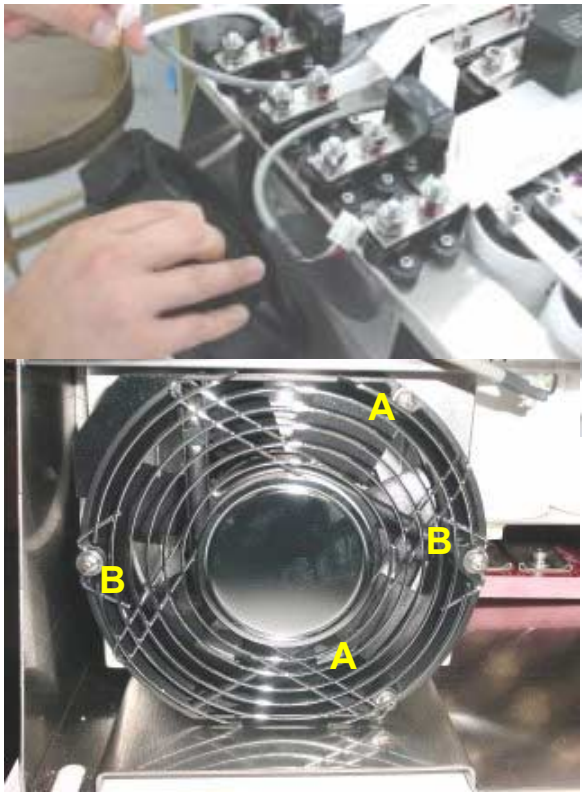
2. Detach the fan guard by removing the four fan fixing screws – see Figure 30.
3. Withdraw the fan guard and withdraw the fan complete with the attached lead.

Figure 30: Removing the Fan Fixing Screws

4. Remove the Fan – see Figure 31

Fan Installation

1. Pass the 2-pin connector from the lead attached to the fan between the current sensor mounting bracket and the wall of the module.
2. Position the fan so that the label is visible when it is placed against the fan bracket. The fan sucks air from the heatsink and the concave surfaces of the fan blades will be visible when it is installed.



3. Leaving the fan guard unattached, secure the fan with fixing screws A (see Figure 32). Position the fan guard as shown ensuring that it is the right way round. Secure with fixing screws B. Ensure that the fan blades rotate freely after all screws have been tightened.
4. Attach 2-pin connector to J14 on the MA2287 gate drive board.

Figure 32: Fan Installation Complete

Pre-Charge Resistor Assembly (A300302)

The pre-charge resistor is a network of six strip heater resistor elements attached to a insulating base. Removal

Figure 33: Pre-charge Resistors Installed

1. Position the module so that access to the bottom fixing screws is possible.
2. Remove the two screws and nuts that secure the inside corners of the pre-charge resistor.
3. Remove the four pre-charge resistor fixing screws from the side of the module.
4. Partly withdraw the assembly far enough to provide access to the terminals for wires #21 and #22.
5. Disconnect wires #21 and #22. Take care not to allow the resistor terminal studs to unscrew from the body of the resistor element.
6. Completely withdraw the assembly.

Figure 34: Bottom Fixing Screws for the Pre-charge Resistor

Figure 35: Removing the Pre-charge Resistors

Figure 36: Removing the Pre-Charge Resistors

Testing

Measure the resistance between wires #21 and #22.

The correct value of resistance is 64 ohms between the points shown in Figure 37. The value measured should be between 52 and 76 Ω. A high value of resistance indicates that a resistor is open-circuit. A low value of resistance indicates that a resistor has become short-circuit. Replace all of the resistor elements if damage has occurred.

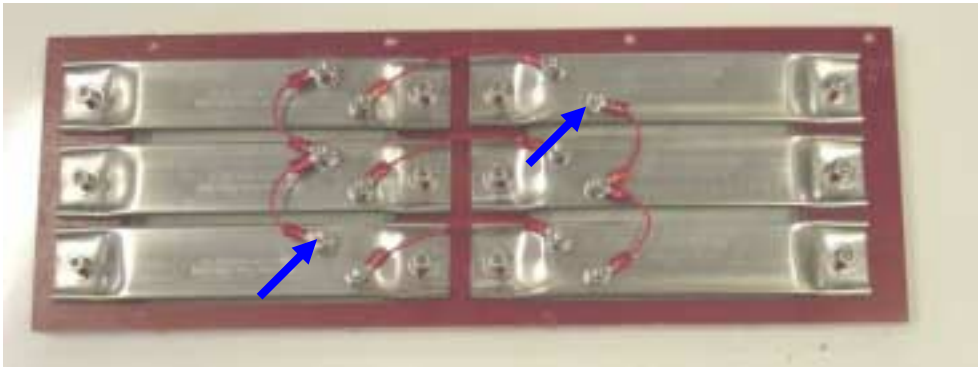


Figure 37: Pre-charge Resistor Assembly (A300302)

Installation

1. Before installation ensure that terminal studs of the resistors are tight – see Figure 38. This is especially important if replacing a resistor that has been removed as the stud may have loosened when the connecting wire was disconnected.
2. Insert the assembly half way into the module.
3. Connect wires #21 and #22.
4. Slide the assembly to its final position.
5. Insert the four pre-charge resistor fixing screws into the side of the module with a torque of 28 in-lb.

Figure 38: Tightening the Pre-charge Resistor Studs

6. Insert the two fixing screws from the bottom of the module and retain with nuts with a torque of 28 in-lb.

Pre-Charge Contactor (K9009-028)

The pre-charge contactor is a sealed DC contactor with permanent magnet blowout. No maintenance is required. A picture is shown in Figure 39.

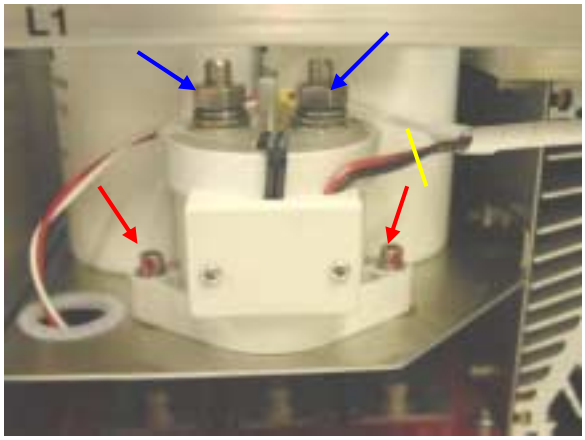


Figure 39: Pre-charge Contactor

Removal

1. Disconnect the coil leads. For units with no in-line connectors in the coil leads, cut the leads 4 inches from the contactor body (shown by a yellow line in Figure 39). Install ¼ inch female quick-connect terminals on the leads attached to the harness. See Table 31 for part numbers of the crimp utility and quick-connect terminals.
2. Disconnect wires #20 and #21 from the contact terminals – see the blue arrows in Figure 39.
3. Remove the fixing screws (labeled with red arrows in Figure 39) and withdraw the contactor.

Testing

A 24V power supply that is able to supply a peak output of 10A is required to test the contactor.

Apply 24V to the coil. The red lead must be connected to the positive side.

Confirm that the contact resistance is near zero when the coil is activated and infinite when the coil is inactive. Distinct clicks will be heard when the coil is activated and deactivated.

Installation

Reverse all steps of the removal procedure. If replacing a contactor that does not have in-line connectors, install two-¼ inch male quick-connect terminals to the contactor leads. The install torques for the fixing screws and contact terminals should be 28 and 85 in-lb respectively.

Ensure that the polarity of the coil and the contact leads is correct.

Power Semiconductor Assembly

The following section covers replacement of power semiconductors, current sensors, precharge diode, filter capacitors and voltage balancing resistors.

Removing the PCB Tray

1. From the MA2287 gate drive board disconnect J1, J2, J3, P1, P2, P3, J8, J9, J10, J11, J12 and J14.

2. From the MA2288 voltage transducer board disconnect P4, P5, P6, P7, P8, P9, P10 and P11. Figure 40 shows the A300 Motor Controller with the top level removed and the cables mentioned above disconnected.

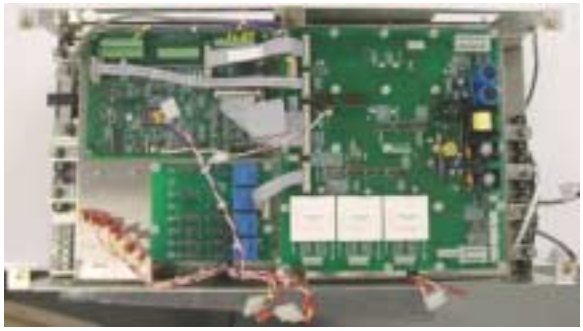


Figure 40: Connectors Unplugged from MA2287 and MA2287 for PCB Tray Removal

3. Remove the PCB fixing screws from the side of the module – see Figure 41 (reinstallation torque – 28 in-lb).

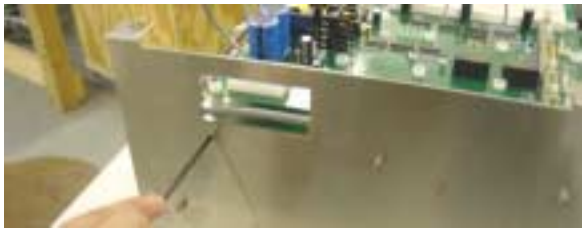


Figure 41: Removing the A300 Control Board Layer

4. Completely withdraw the PCB tray assembly. Ensure that no cables or connectors get snagged or torn – see Figure 42.

Figure 42: PCB Tray Removal

Pre-charge Diode (D9002-003)

The pre-charge diode is a 25A, 1600V 3-phase rectifier. The AC terminals are never connected in this assembly. Disconnecting wires #22 and #23 and removing the fixing screw will allow the diode to be removed.

When replacing the diode it is not necessary to use any heatsink compound. Ensure that wire #23 is connected to the positive (+) side of the rectifier. A torque of 40 in-lb is required for remounting of this device.

Figure 43: Pre-Charge Diode

Balancing Resistors (R9120-001)

In the A300 Motor Controller Module, there are four balancing resistor assemblies, which are fitted to the filter capacitor terminals. Each resistor contains two separate 10 kΩ elements.

Disconnecting the leads from the terminals, removing the fixing screws and withdrawing the component will allow the balancing resistors to be removed.

When replacing a balancing resistor ensure that the busbar link between two of the resistor terminals is present. The fixing screws should be installed with 40 in-lb of torque.

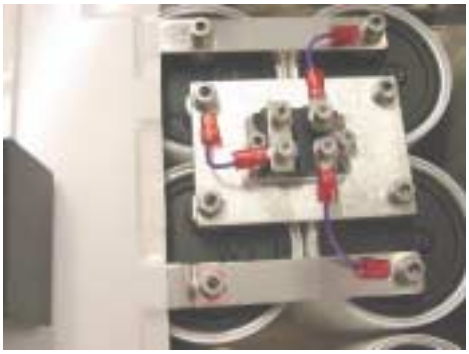


Figure 44: Balancing Resistors

Busbar Removal

1. Remove the 12 M8 hexagon socket screws from the IGBT terminals (re-installation torque – 85 in-lb) – these are labeled with red arrows in Figure 45.
2. Withdraw the three snubber capacitors (C9002-002).

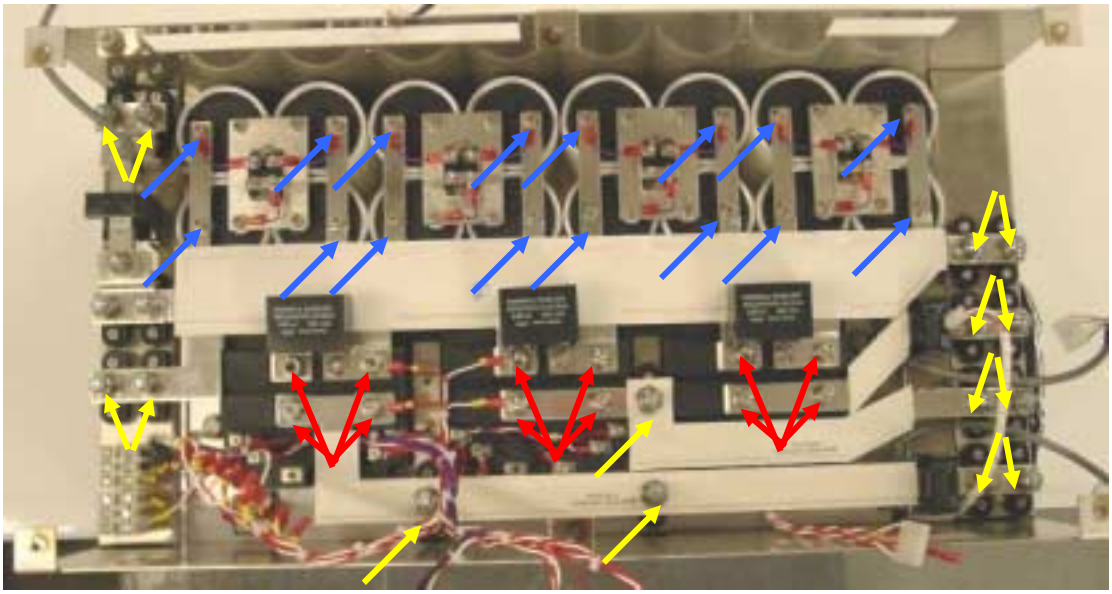


Figure 45: Snubber Capacitor, Current Sensor and Busbar Fixing Screws

3. Remove the 13 9/16" nuts from the stand-offs, shown in the yellow arrows in Figure 45.

4. Remove the four fixing screws securing the current sensors near terminals T1 and T3 – see Figure 46. These fixing screws have a re-installation torque of 40 in-lb

5. Withdraw the three output busbars with the two current sensors (you can leave the current sensors attached).

6. Remove 16 screws (labeled by the blue arrows in Figure 45 – with a re-install torque of 120 in-lb) connecting the positive and negative DC busbars to the filter capacitors. It is not necessary to remove the balancing resistors.

7. Withdraw the DC positive and negative busbar assembly.

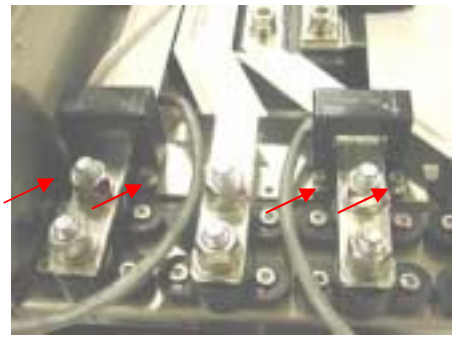


Figure 46: CT1 and CT3 Fixing Screws

Heatsink Thermistor (A300301)

The heatsink thermistor has a resistance of 10 kΩ at 25 °C (77 °F). As the temperature increases the resistance gradually falls. At 87 °C (189 °F) the resistance is 1 kΩ. The thermistor is shown in Figure 47.

Figure 47: Heatsink Thermistor

Removal

1. Cut the cable ties to free the thermistor lead from the harness.
2. Unscrew and withdraw the thermistor from the heatsink.

Installation

1. Ensure that the heat-shrink sleeve protects the fragile leads of the thermistor.
2. Fit the thermistor to the heatsink. Do not tighten more than 10 in-lb.
3. Tie the lead into the wiring harness using new cable ties.

Insulated Gate Bipolar Transistor (IGBT) Removal (N6001-051)

1. Remove the 5 control connections from the IGBT gate, emitter and collector terminals.
2. Remove the six fixing screws – the blue arrows in Figure 48.
3. Withdraw the IGBT – see Figure 49.

If the IGBT is to be saved for future attach two wire links or self-adhesive copper strips from terminals E1 to G1 and from E2 to G2. Without these connections the IGBT is vulnerable to damage from static discharge when handled in an environment that is not static-controlled.

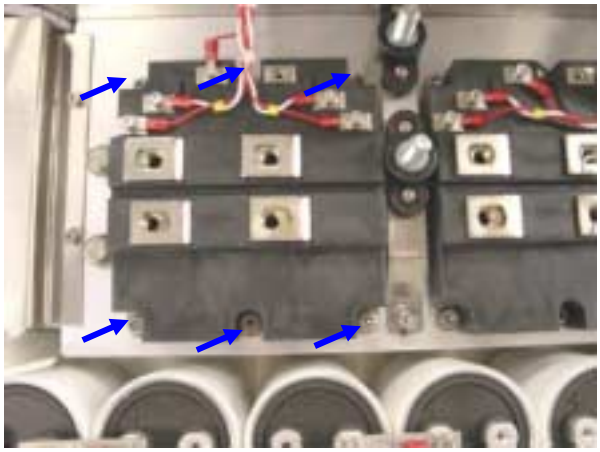


Figure 48: IGBT Fixing Screws

Figure 49: IGBT Removal

IGBT Replacement

1. Thoroughly clean the site of the IGBT ensuring that all residue of old heatsink compound is removed. WD40 may be used to remove remaining smears. DO NOT TRY TO INSTALL AN IGBT USING THE RESIDUAL HEATSINK COMPOUND. The heatsink compound has a solvent that allows it to flow easily into small gaps when it is fresh. This solvent is lost over time.
2. Apply heatsink compound (U1001-049) to the base of the IGBT as shown in Figure 50. Only a thin layer is required. Take care to ensure that no foreign material adheres to the heatsink compound after it has been applied.

Figure 50: Applying Heatsink Compound

3. Position the IGBT in the correct (the same as originally placed) orientation and install as shown in Figure 51.
4. Install the fixing screws loosely. Half tighten the screws and then tighten diagonally and diametrically opposite screws to maintain even pressure on the IGBT base – use a final torque of 45 in-lb.
5. Reconnect gate, emitter and collector leads.
6. Remove any excess heatsink compound.

Figure 51: Installing the IGBT

Filter Capacitors (C9002-032)

The A300 module uses a bank of electrolytic capacitors to make up the equivalent of a single, large capacitor. The capacitors are arranged in groups of four. Each group has two parallel pairs connected in series. A voltage-balancing resistor connected across each pair ensures that the bus voltage is divided equally between the two pairs. By using four separate groups, the damage caused by failure of a capacitor is limited to the capacitors within the group.

The life of electrolytic capacitors is a complex function of temperature, applied voltage and ripple current. In the A300 application under normal operating conditions, the life of the capacitors is expected to exceed 50,000 hours of active usage or 200,000 hours of inactive usage with line voltage applied.

Capacitors that have been in storage for more than five years without voltage applied to them exhibit higher than normal leakage. If a controller or a vehicle has been in storage for an extended period of time precautions should be taken to ensure that damage will not occur.

Table 23: Filter Capacitor Long-Term Storage Requirements

Storage Period	Storage Requirements
Up to 1 year:	No precautions necessary
1 year to 3 years	Apply line voltage to vehicle for 2 hours before driving
More than 3 years	Apply 2/3 of normal line voltage to vehicle for 2 hours and then normal line voltage for 2 hours before driving.

Capacitor Inspection and Testing

Capacitors should be replaced if fluid is leaking from the vent or if the can is swollen or ruptured. It is common to find a trace of fluid around the vent of a new capacitor remaining from the filling process. This should be ignored if no more fluid appears after it has been cleaned off.

If it is suspected that there is a faulty capacitor in the group proceed as follows:

Connect a high-voltage low-current supply across one pair DC busbar connections of a group. The polarity of the supply must agree with the markings on the capacitor can. DO NOT APPLY

REVERSE VOLTAGE. A resistor of 1 kilohm should be used in series with the supply to limit the current in the event of a capacitor failure.

Measure the DC voltage across each capacitor in the circuit. The difference in voltage measurements across each capacitor should not exceed 3% of the total. Example: If 600V is applied to the pair, the lower voltage should not be less than 291V and the higher voltage should not exceed 309V.

Repeat for the other pair of DC bus connections.

CAUTION: ALWAYS ALLOW CAPACITORS TO DISCHARGE TO A SAFE VOLTAGE BEFORE TOUCHING THE TERMINALS OR OTHER PARTS OF THE TEST CIRCUIT.

If a group of filter capacitors has failed the voltage balance test ALL OF THE CAPACITORS IN THE GROUP SHOULD BE REPLACED. It is important that all of the capacitors have identical leakage characteristics. If possible, the replacement capacitors should have the same or very similar date codes.

Filter Capacitor Removal

1. Remove the DC bus bar assembly. (The output busbars connected to T1, T2 and T3 may be left in place.)
2. Remove the balancing resistor assembly – see Figure 52.
3. Remove the M12 nylon retaining nut from the bottom of the capacitor and withdraw the capacitor - see Figure 53.

Figure 52: Removing the Balancing Resistor Assembly

Filter Capacitor Replacement

1. Install the replacement capacitors and the nylon retaining nuts. Ensure that all of the positive (+ marked) terminals are oriented towards the output terminals (T1 through T4) end of the module. Ensure that the pilot on the nylon nuts engages with the hole in the supporting bracket. Keep the nut sufficiently slack for the can to rotate slightly during alignment with the busbars.
2. Fit the balancing resistor assembly. Do not tighten the screws.
3. Fit the DC busbar assembly. Ensure that the capacitor terminals align with the busbar holes before inserting the screws. Do not tighten the screws until all are inserted.
4. Fully tighten all of the terminal screws using a torque of 40 in-lb.
5. Tighten the nylon retaining nuts. DO NOT OVERTIGHTEN.

Figure 53: Removing the Capacitor

Voltage Transducer Board (MA2288)

The voltage transducer board consists of four closed-loop Hall-Effect transducers. These produce output currents from the secondary circuit proportional to the current in the secondary circuit in the same manner as a current transformer.

High-voltage resistors on the primary side are used to determine the ratio of current to voltage.

The four transducers are used to measure respectively:

1. Motor 1 Armature Voltage
2. Motor 2 Armature Voltage
3. Line Voltage to DC Bus Voltage Difference
4. DC Bus Voltage

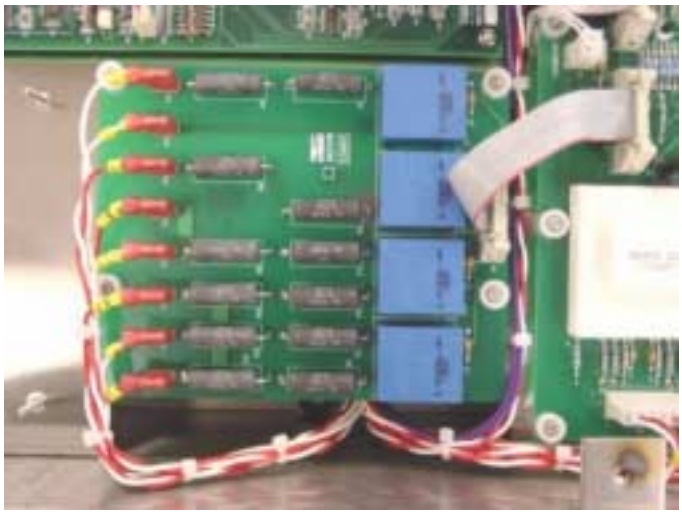


Figure 54: MA2288 - Voltage Transducer Board

Removal

1. Unplug the ribbon cable from MA2288 J4 – see Figure 54.
2. Withdraw the high-voltage circuit connections from P4, P5, P6, P7, P8, P9, P1 and P11.
3. Remove the four fixing screws.
4. Withdraw the board complete with nylon insulators.

Installation

Install the board by carrying out the above steps in reverse order. Ensure that the high voltage connections are firm. Squeeze together the receptacles to ensure that they grip tightly.

Gate Drive Board (MA2287)

The gate drive board contains many interface circuits as well as the gate drives.

If an IGBT failure has occurred it is possible for the associated gat drive circuit to be damaged as well. If it is suspected that this has happened proceed as follows:

1. Apply a 24V supply to pins 1(+) and 15(-) of J15.
2. Confirm that all four power supply indicator LEDs are lit.
3. Check that the voltage gate voltages applied to all IGBT gate terminals (white wires) relative to their emitters (red wires) is between –6V and –8V. These voltages can be measured at the following points:
    1. J1 pin 1 to J1 pin 2
    2. J1 pin 6 to J1 pin 5
    3. J2 pin 1 to J1 pin 2
    4. J2 pin 6 to J2 pin 5
    5. J3 pin 1 to J3 pin 2

6. J3 pin 6 to J3 pin 5This test may be carried out with the IGBT gate leads connected or unplugged.

Note that this test is not a complete test of the gate drive circuits. It merely serves to ensure that the gate drive circuit produces a negative bias that on all of the IGBT gates so that it is safe to apply voltage to the DC bus.

Figure 55: Gate Driver Board

Removal

1. Unplug all of the connectors from the gate drive board.
2. Remove all of the fixing screws.
3. Withdraw the gate drive board.

Installation

Install the board by carrying out the removal steps in reverse order.

Control Board (MA2259)

The MA2259 control board for the A300 uses a microcontroller to read digital and analog input and feedback signals and deliver output signals for controlling the power semiconductors and other hardware of the A300 system.

The MA2259 board uses flash memory to store the microcontroller executable program. This allows the program to be erased and updated remotely using a serial communication port.

The MA2259 board also uses a similar but separate device for storage of adjustable settings. All adjustments are carried out remotely using the LCD programming module.

The board is constructed using surface-mount technology, which allows a high level of functionality to be achieved in a small space on a single board. Figure 56 shows this board as it is in the A300 Motor Controller.

Figure 56: Main Control Board

Figure 57: Main Control Board with Connectors Unplugged

Removal

1. Unplug connectors X1, X3, X6, X7 and X5060. Refer to Figure 57.
2. On earlier control boards (MA2259) disconnect the flash programming control relay from J13 of the gate drive board.
3. On later boards (MA2259-1 and greater) disconnect the 2-pin connector from J1 of the control board.
4. Remove fixing nuts and withdraw the board.

Installation

1. Check that the position of the movable links shown in Figure 58:
    a. LK2 links pins 1 to 2
    b. LK3 links pins 1 to 2
    c. LK4 links pins 2 to 3
2. Check that the position of the DIP switches shown in Figure 59 are from position 1 to 8 respectively OFF, ON, OFF, ON, OFF, OFF, OFF, OFF.
3. Check that all of the S1 switches are in the OFF position.
4. Install the board and fit the four retaining nuts. For the MA2259 version use insulating washers for the two fixings opposite to the green connectors. For the MA2259-1 version (shown) it is permissible to use non-insulating hardware for all fixings.
5. Reconnect the plugs to X1, X3, X6, X7 and X5060.
6. If fitting MA2259 replace fit the relay link between LK and J13 of the gate drive board. Connect the short wires of the contact side to the control board. DO NOT FIT A SIMPLE 2-WIRE LINK WITHOUT A RELAY WHEN USING MA2259. Secure the relay to the MA2259 board with silicone RTV.
7. If fitting MA2259-1 replace the link between J1 and the gate drive board with a straight 2-wire jumper without a relay. ENSURE THAT THE BOARD IS MA2259-1 OR LATER BEFORE FITTING A SIMPLE 2-WIRE LINK.

Figure 58: Control Board Link Positions

Figure 59: Control Board DIP Switch Positions

Current Sensors (T9003-013)

The current sensors consist of a high-permeability magnetic core that is fitted around the conductor carrying the current to be measured. A small Hall-Effect magnetic field sensor located in a gap of the core produces a small output voltage proportional to the core flux, which in turn is proportional to the current passing through the core. An amplifier converts the small Hall-Effect signal to a larger signal such that 4V corresponds to the 600A nominal specification of the device.

Removal

CT1 and CT3:

Refer to Figure 46 on page 49 of this document.

1. Remove the pcb tray.
2. Remove busbars connected to T1 and T3.
3. Withdraw the current sensors complete with connecting leads.

CT2:

1. Remove the 9/16” nuts securing the busbar link shown in Figure 60.
2. Withdraw the current sensor complete with connecting lead.

Installation

1. Fit the connecting lead.
2. Mount the current sensor on the busbar using a torque of 28 in-lb. The arrow on the body must be in the direction shown by Figure 46 and Figure 60.
3. Re-install the busbars (installation torque of 85 in-lb) and pcb tray.

Figure 60: CT2

4.5.4 Specifications

Table 24: A300201 Specifications

Specification Type	Specification
Maximum Motor Power	2 x 75HP
Motor Voltage	2 x 300V
Nominal Supply Voltage	600V
Undervoltage Trip Level	300V
Overvoltage Trip Level	840V
Absolute Maximum Voltage (not operating)	1040V
Continuous Output Current (armature and field)	200A
Peak Armature Current	400A
Peak Field Current	300A
Control Supply Voltage Range	16V to 30V
Control Supply Current at Minimum Control Supply Voltage	3A
Maximum Heatsink Temperature	90 deg C
Maximum Ambient Temperature	55 deg C

Specification Type	Specification
Minimum Temperature	-20 deg C

4.6 Brake Chopper Module (A800969)

The brake chopper module uses a single IGBT module to switch the externally-mounted brake resistor directly across the DC bus of the propulsion unit when it is necessary to dump energy recovered from the motors during braking. The brake chopper module has its own power supply, gate drive circuit and control circuit and is able to function without any connection to the motor control module.

A 6-wire interface to the main motor control module allows the characteristic of the brake chopper to be adjusted or modified to suit operating conditions and allows brake chopper faults to be detected and logged.

When the brake chopper is disconnected from the motor control module the switching voltage is set so that the IGBT turns on when the DC bus voltage is 800V.

Figure 61: Brake Chopper Module - A800969

When the motor control module interface is connected an analog signal from the main controller is used to depress the switching voltage by up to 200V. When the input signal is +10V the IGBT turns on at a bus voltage of 600V.

While the propulsion unit is not enabled the controller sets the switching level to its maximum of 800V in order to avoid unwanted operation of the brake chopper yet still provide good protection from line transients above 800V.

While the propulsion system is enabled, the switching level is depressed to a lower level, typically 700V, so that regenerating cars cannot impress high voltages on the network.

The brake chopper has a synchronization signal for the purpose of balancing the braking load of the other propulsion unit. The synchronization signal is a bi-directional 24V signal and is linked to the same signal of the other brake chopper. The first brake chopper to switch drives the synchronization line to +24V. This is detected by the other brake chopper which then also turns on.

The Brake Chopper Module is shown in Figure 61.

4.6.1 Inspection and Testing

CAUTION: THE HEATSINKS PROTRUDING THROUGH THE LID APERTURES ARE AT A HIGH POTENTIAL WHEN THE MODULE IS CONNECTED TO THE A SUPPLY. DO NOT TOUCH THE HEATSINKS.

The brake chopper module has a preset potentiometer for switching voltage adjustment. This is factory set and does not normally require adjustment.

To test the brake chopper voltage threshold it is necessary to provide an adjustable DC supply of 850V DC at a current of 1A and a resistive load of approximately 1,000 ohms. Six 120V/100W light bulbs connected in series is recommended.

Connect the variable DC power supply to P(+) and N(-).

Connect the resistive load to R1 and R2.

Ensure that an interface lead containing a link between pins 5 and 17 of the control connector is fitted.

Gradually increase the power supply voltage to 850V. The brake chopper should turn on at between 790V and 820V.

Gradually reduce the power supply voltage. The brake chopper should turn off at between 770V and 800V.

Adjust the preset potentiometer to obtain switching points within these ranges.

4.6.2 Removal and Replacement

1. Disconnect from power terminals from P, N, R1 and R2.
2. Disconnect the sub-D control connector.
3. Remove the fixing screws and withdraw the module.

Figure 62: Removing the Brake Module Lid

4.6.3 Replacing Parts

Control Board (MA2289)

1. Remove the six lid fixing screws. Withdraw the lid. Figure 62 should show this.
2. Unplug J1, J2 and P1 harnesses from the control board.
3. Withdraw the control board – see Figure 63.

When re-installing the board ensure that the connector for P1 is tight. Figure 64 shows the control board.

IGBT Removal

1. Remove the lid and the control board.
2. Remove the connecting busbars and the snubber capacitor.
3. Remove the IGBT mounting screws. Withdraw the IGBT module.
4. Remove the gate lead harness.

Installation

1. Attach the gate lead harness.
2. Apply heatsink compound to the IGBT base. (see Figure 50 on page 51 of this document).
3. Install the IGBT. (See Figure 51 on page 52 of this document). Half tighten the screws before applying the full tightening torque.

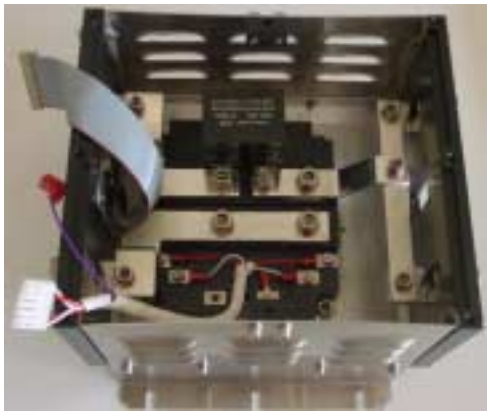


Figure 63: Brake Module with Circuit Board Removed

4. Fit the busbars and the snubber capacitor.
5. Fit the control board and the lid.

4.6.4 Specifications

See Table 25 for the Brake Module specifications.

Table 25: Brake Chopper Module Specifications

Nominal System Voltage	600V
Minimum Operating Voltage	550V
Maximum Operating Voltage	1100V
Continuous Operating Current	200A
Peak Operating Current	800A
Minimum Resistor Value (800V input)	1.0 ohm
Standby Current (800V input)	40mA
Maximum Heatsink Temperature	90 deg C
Maximum Ambient Temperature	55 deg C
Minimum Temperature	-20 deg C

Figure 64: Brake Module Circuit Board - MA2289

5 Firmware

Firmware is the programmed memory device or devices used to permanently hold an executable program in a computer-based system. In the A300 system executable programs are found in three locations:

1. The on-chip ROM (Read Only Memory) found in the micro-controller of the MA2259 control board. This is a small program built into the micro-controller chip used for the purpose of loading other programs through the serial port. This program is embedded into the chip during manufacture and cannot be changed.
2. The Flash EPROM (Erasable Programmable Read Only Memory) located on the MA2259 control board. This is the program that controls the operating sequence and many control functions of the A300 propulsion system. It is created by Saminco Inc. using a high-level language compiler and loaded into the MA2259 board by serial communication. Flash EPROM is erased electrically without removing the memory from the board. After it has been erased the A300 will not function until a new program is installed.
3. The EPROM (Erasable Programmable Read Only Memory) located in the MA2263 board in the LCD module. This program converts message received from the main propulsion unit to text that is displayed on the LCD and converts push-button operations into messages that are transmitted to the main propulsion module. The device used to store this program is erased by exposing to strong ultra-violet light. After exposure it can be reprogrammed. The EPROM fitted may be a one-time-programmable (OTP) type. This has the same UV-erasable chip inside has no window to permit UV exposure. The firmware in this location is created by Saminco Inc. using a high-level language compiler. It affects operation of the A300 only when the display is connected for checks and parameter adjustment.

5.1 Identifying Installed Firmware

1. Connect the LCD module.
2. Cycle the control supply power or momentarily apply the RESET input.
3. Wait until the display changes from “Brookville”/”initialization” to “Brookville”/”Streetcar”
4. Figure 65.
5. Press the ▲ key once more to indicate the software version installed in the main propulsion unit – see Figure 66.

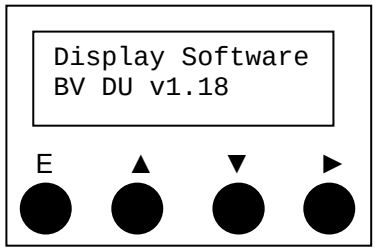


Figure 65: LCD Module Software Version Display Example

5.2 Installing New Firmware

Software updates can be installed using a laptop PC connected to the serial port.

Consult Saminco Inc. before attempting to make any changes to the installed firmware of the main propulsion unit.

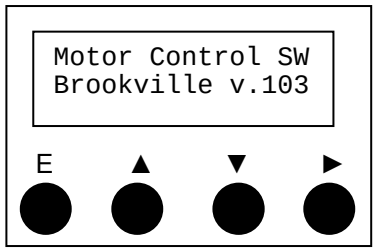


Figure 66: Motor Control Software Version Display Example

Press the ▲ key indicate the software version installed in the LCD module EPROM – see

6 Parameters and Adjustments

6.1 Block Diagram

6.2 Traction Control

6.3 Brake Level

6.4 Slip-Spin Sensitivity

7 Diagnostics and Fault Finding

7.1 Fault Log

7.2 Fault Finding Guide (Flowchart)

7.3 Troubleshooting

Table 26: Fault Codes and Corrective Action

Fault Code 'Text Message'	Drive Action	Comment
CUV 'Control Pwr Loss'	• Disable IGBTs • Disable parameter adjustment. • Wait for PSU- ready signal to become low.	Indicates that the 24V power supply has fallen below 19V. If the fault occurred while a movement was in progress: Restart movement power restored within 1 second, then wait for center OFF position if power restored after more than 1 second.
UV1 'Undervoltage'	• Disable IGBTs • Wait for the center OFF position.	Indicates that the main DC supply voltage is too low or that the M contactor did not close.
OH1 'Over Temp' Alarm	•	
OT1 'Heatsink Temp' Trip	• Disable IGBTs • Wait for the center OFF position and heatsink temperature to drop below 90 °C.	Indicates that an excessive heatsink temperature rise has occurred.
SC 'Short Circuit'	• Disable IGBTs • Wait for the center OFF position.	
OV 'Overvoltage'	• Disable IGBTs • Wait for the center OFF position.	Indicates excessive DC input voltage or supply no able to accept reverse current flow during regeneration.
FL 'Field Loss'	• Disable IGBTs • Wait for the center OFF position.	Indicates that the motor field loop is open or that IGBTs Q2 or Q3 are not conducting.
MOL 'Motor Overload'	• Disable IGBTs • Wait for the center OFF position.	Wait for motor, or check motor.
EXT 'External Limit Switch'	• Disable IGBTs • Wait for the center OFF position. • Lowering Disabled.	Slack Cable condition detected. Only hoisting is permitted until reset.
MS 'Master Switch'	• Disable Drive	Master switch not in OFF position.

8 Customer Support

For customer support, or help with this manual please contact:

Saminco Inc.
10030 Amberwood Road
Ft. Myers, FL 33913, USA
Telephone: (239) 561-1561
Facsimile: (239) 561-1502
http://www.samincoinc.com

Appendix A: Parts List

In order to obtain spare parts for maintenance, please refer to Table 27 through Table 31. The quantities of an entire module are given for reference. Table 27 shows the top-level assembly of the A300 Motor controller. Bolts and easily obtained equipment is not listed. Any of these parts can be ordered by contacting a Saminco Inc. sales representative. See Section <LINKREF> for contact information.

Table 27: A300110 – A300 Motor Controller Parts List

Saminco Part Number	Description	Quantity
A300201 (Table 28)	SERIES MOTOR CONTROLLER MODULE	1
A800969 (Table 29)	BM302-3 400V - 750V 400A BRAKE	1
E9001-207	ENC PCC	1
F9001-007	HOLDER FUSE 1 60A 250V	1
F9001-013	HOLDER FUSE 400A FERRAZ	3
F9002-080	FUSE 15A 1000VAC 750VDC	1
F9002-093	FUSE 250A 700V	2
F9004-004	CLIP FUSE PCB .5"DIA	2
I9001-050	CHOKE DC .5mh 150 AMP W/NOMEX	2
I9001-051	RFI/EMC FILTER	1
J9004-046	JUNC/BLK 3/8-16 STUD	4
K9009-049 (Table 30)	CON DC 1000V 28V DC	1
W6004-175	CABLE 6CON 25PIN SUB-D PLUG	1
W6004-178	CABLE 42PIN CONTROL	1
Y9002128	MIDDLE SLIDE UHMW-PE	2
Y9002129	SLIDE UHMW-PE	2
Y9008052	BUS BAR TCU 4H 0BND 8.8"	2
Y9008161	BUS BAR ALUMINUM	1

Table 28: A300201 – SERIES MOTOR CONTROLLER MODULE

Saminco Part Number	Description	Quantity
A300301	A300 HEATSINK THERMISTOR ASM	1
A300302	A300 PRE-CHARGE RES ASM	1
A300303	A300 FAN ASM	1
C9001-121	CAP 6.8uF 400VDC OTH	1
C9002-002	PCAP 2.5uF 850WV OTH RAD BB	3
C9002-032	PCAP 1800uF/500VDC	16
D9002-003	PWR DIODE BRIDGE 3PH 25A 1200V	1
HM100-004	M10 NYLON CAP/STUD INSUL NUT	16
K9009-028	CON 200A/320DC N/O 9-36V ECON	1
MA2259-3	MA2259-3 CONTROL BOARD	1
MA2287-1	MA2287-1 GATE DRIVE INTERFACE	1
MA2288	MA2288 HIGH VOLTAGE ISOLATION	1

Saminco Part Number	Description	Quantity
N6001-051	IGBT DUAL 800A 1200V 80C	3
R9005-023	RES 5W 5R 5% WIREWOUND	1
R9120-001	RES 120W DUAL 10K 5% SOT227	4
T9003-013	DCCT 600A 1KA PEAK OPEN LOOP	3
V9001-004	STAND-OFF PCB ROUND AL 8mm 6mm	4
W6002-028	RB 16CON 6IN PAN PAN	1
W6002-029	RB 14CON 4IN PAN PAN	1
W6002-035	RB 34CON 5.75IN PAN PAN	1
W6002-036	RB 10CON 11.5IN PAN PAN	1
W6004-176	CABLE 4CON 22AWG 10IN DCCT	2
W6004-180	CABLE CT 6CON 41IN	1
Y9004010	HEATSINK ALUM 8H	1
Y9005054	BASE PLATE ALUM 35H	1
Y9007507	BRK SS 14G 12BND 47H 6PEM	1
Y9007508	BRK SS 18G 8H 2BND	1
Y9007509	BRK SS 16G 1H 3BND 5PEM	2
Y9007510	PC TRAY SS 16G 5BND 5H 43PEM	1
Y9007511	BRK SS 16G 22H 2BND 6PEM	1
Y9007512	BRK SS 18G 6BND 21H 19PEM	1
Y9007512A	FAN BRCK 18G SS 12BND 6H 4PEM	1
Y9007513	BRK SS 16G 6BND 2H 18PEM	1
Y9007514	BRK SS 16G 6BND 20PEM	1
Y9007517	BRK STEEL 5H 0BND ZINC	4
Y9007518	COVER SS 14G 4H 4BND 6PEM	1
Y9008125	BUS BAR 25.4mm X 7.5mm X 1mm	4
Y9008163	BUS BAR TCU 4H 2PEM 0BND	4

Table 29: A800969 – BM302-3 400V - 750V 400A BRAKE

Saminco Part Number	Description	Quantity
C9002-002	PCAP 2.5uF 850WV OTH RAD BB	1
MA2289-1	MA2289-1 650V BRAKE CHOP CTRL	1
N6001-051	IGBT DUAL 800A 1200V 80C	1
Y9002126	BACK PLATE DELRIN (A401)	2
Y9002127	PC SUPPORT DELRIN (A401)	2
Y9002130	TOP COVER DELRIN	1
Y9003207	BOTTOM PLATE AL 14PEM 4BND 6H	1
Y9004051	HEAT SINK AL 13H	1
Y9007166	BRK ALUM 16G 4PEM SUB-D PUNCH	1
Y9007168	SIDE COVER SS 3BND 4PEM 6H	2
Y9008142	BUS BAR 1H 2PEM 1BND	4
Y9008152	BUS BAR TCU 3H 2BND	1
Y9008153	BUS BAR TCU 2BND 2H	1
Y9008159	BUS BAR TCU 2BND 2H 1PEM	1

Saminco Part Number	Description	Quantity
Y9008160	BUS BAR TCU 0BND 2H 1PEM	1

Table 30: K9009-049 – CON DC 1000V 28V DC – Replacement Parts

Saminco Part Number	Description	Quantity
K9010-001	DPM L-67 AUX CONTACT	1
K9010-002	DPM L-67 REPLACEMENT COIL	1
K9010-003	DPM L-67 MOVING CONTACT	1
K9010-004	DPM L-67 STAT CONTACT	2
K9010-005	DPM L-67 ARCING CONTACT	1
K9010-006	DPM L-67 SHUNT	2
K9010-007	DPM L-67 COIL RETAINING O-RING	1
K9010-008	DPM L-67 AUX BLOWOUT COIL	1
K9010-009	DPM L-67 ARC CHUTE	1
K9010-010	DPM L-67 MOVING CONTACT SPRING	1
K9010-011	DPM L-67 ARC CONTACT SPRING	1
K9010-012	DPM L-67 KICKOUT SPRING	1
K9010-013	DPM L-67 LOAD ARC HORN SPRING	1
K9010-014	DPM L-67 LATCH CAL. SPRING	1
K9010-015	DPM L-67 LATCH BIAS SPRING	1

Table 31: Miscellaneous Components

Saminco Part Number	Description	Min. Quantity/Order
U1001-011	CRIMPER DISCONN. AND SPLICES	1
P1001-028	CRIMP DISCONNECT FEMALE RED	50
P1001-029	CRIMP DISCONNECT MALE RED	50
U1001-049	SILICONE HEATSINK COMPOUND 5OZ	1

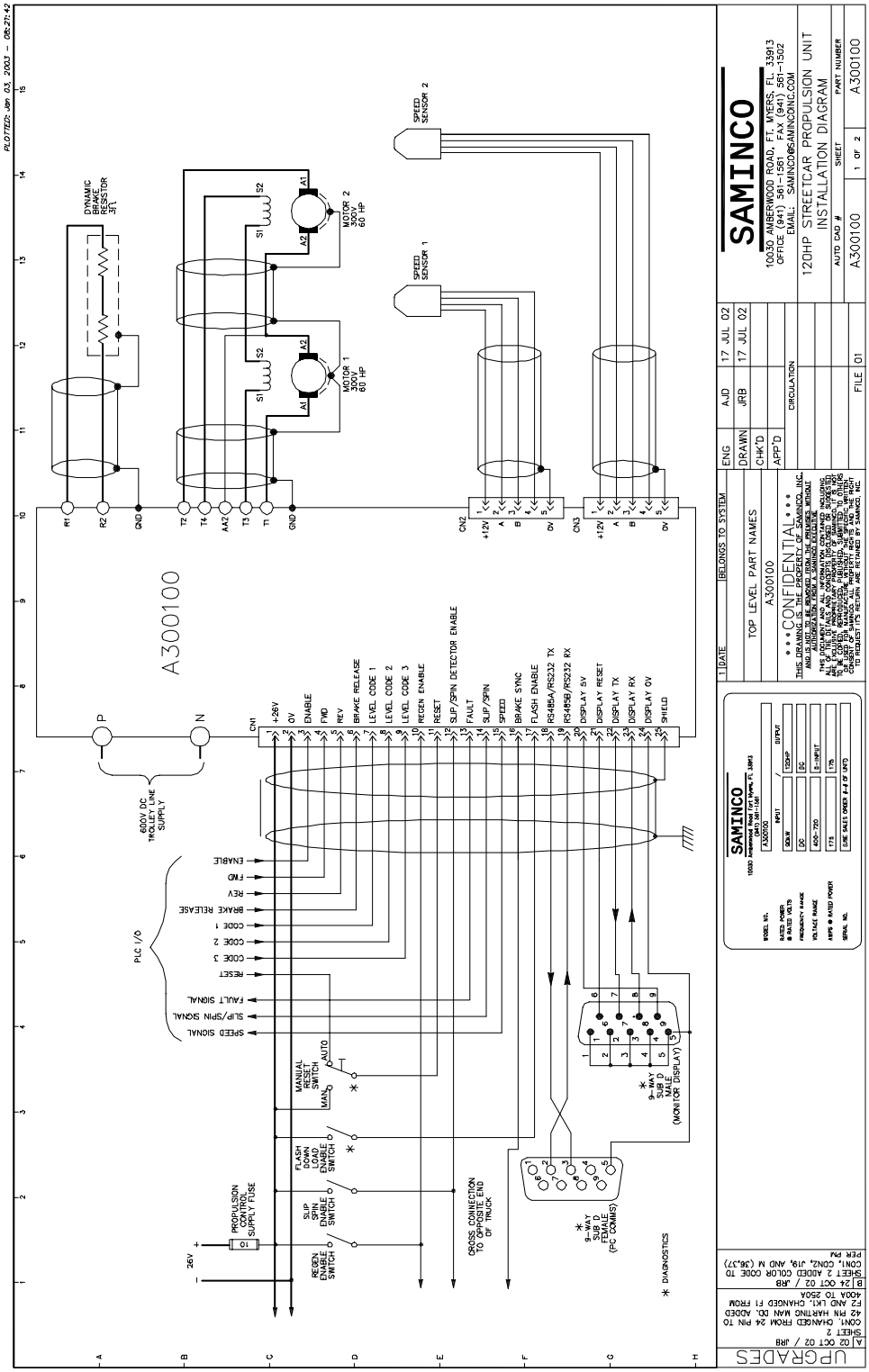
Appendix B: Schematics

This section is a compilation of all the electrical schematics for the A300 system as of this document release date. Updated drawings may be published after this date and can acquired through a Saminco Representative.

The drawings in this section are outlined in Table 32 below.

Table 32: Drawings in Appendix B

Drawing Number	Drawing Description	Revision Level	Release Date
A300100 Page 1 of 2	120HP STREETCAR PROPULSION UNIT - INSTALLATION DIAGRAM	1	24-Oct-02
A300100 Page 2 of 2			
A300201 Page 1 of 2	PCC STREETCAR - SERIES MOTOR CONTROLLER	1	18-Nov-02
A300201 Page 2 of 2			
A800969 Page 1 of 1	BRAKE CHOPPER MODULE - 600V	1	24-Sep-02


A300100
SAMINCO
10030 AMBERWOOD ROAD, FT. MYERS, FL. 33913
OFFICE (941) 561-1561 FAX (941) 561-1502
EMAIL: SAMINCO@SAMINCOINC.COM
120HP STREETCAR PROPULSION UNIT
INSTALLATION DIAGRAM
AUTO CAD #
SHEET
1 OF 2
PART NUMBER
A300100
TOP LEVEL PART NAMES
A300100
BELONGS TO SYSTEM
ENG
DRAWN
JRB
17 JUL 02
CHK'D
APP'D
AJD
17 JUL 02
CIRCULATION
FILE 01
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CONSENT OF SAMINCO. ALL RIGHTS, TITLE AND INTEREST
TO RESIDES IN SECTION ARE RETAINED BY SAMINCO, INC.
UPGRADES
A 02 OCT 02 / JRB
SHEET 2
CONN. CHANGED FROM 24 PIN TO
42 PIN HARTING MAN DD. ADDED
F2 AND LK1. CHANGED FI FROM
400A TO 250A
B 24 OCT 02 / JRB
CONN1, CONN2, J19, AND M (36-37)
PER PM
PLOTTED: APR 03, 2003 - 08:21:42
DYNAMIC BRAKE RESISTOR .3Ω
MOTOR 1 300V 60 HP
MOTOR 2 300V 60 HP
SPEED SENSOR 1
SPEED SENSOR 2
600V DC TROLLEY LINE SUPPLY
PROPULSION CONTROL SUPPLY FUSE
REGEN ENABLE SWITCH
SLIP SPIN ENABLE SWITCH
FLASH DOWN LOAD ENABLE SWITCH
MANUAL RESET SWITCH
CROSS CONNECTION TO OPPOSITE END OF TRUCK
9-WAY SUB D MALE (MONITOR DISPLAY)
9-WAY SUB D FEMALE (PC COMMS)
DIAGNOSTICS
PLC I/O
SPEED SIGNAL
SLIP/SPIN SIGNAL
FAULT SIGNAL
RESET
CODE 3
CODE 2
CODE 1
BRAKE RELEASE
REV
FWD
ENABLE
+26V
0V
ENABLE
FWD
REV
BRAKE RELEASE
LEVEL CODE 1
LEVEL CODE 2
LEVEL CODE 3
REGEN ENABLE
RESET
SLIP/SPIN DETECTOR ENABLE
FAULT
SLIP/SPIN
SPEED
BRAKE SYNC
FLASH ENABLE
RS485A/RS232 TX
RS485B/RS232 RX
DISPLAY 5V
DISPLAY RESET
DISPLAY TX
DISPLAY RX
DISPLAY 0V
SHIELD
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CN2
CN3
+12V
A
B
0V
SAMINCO
A300100
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OUTPUT
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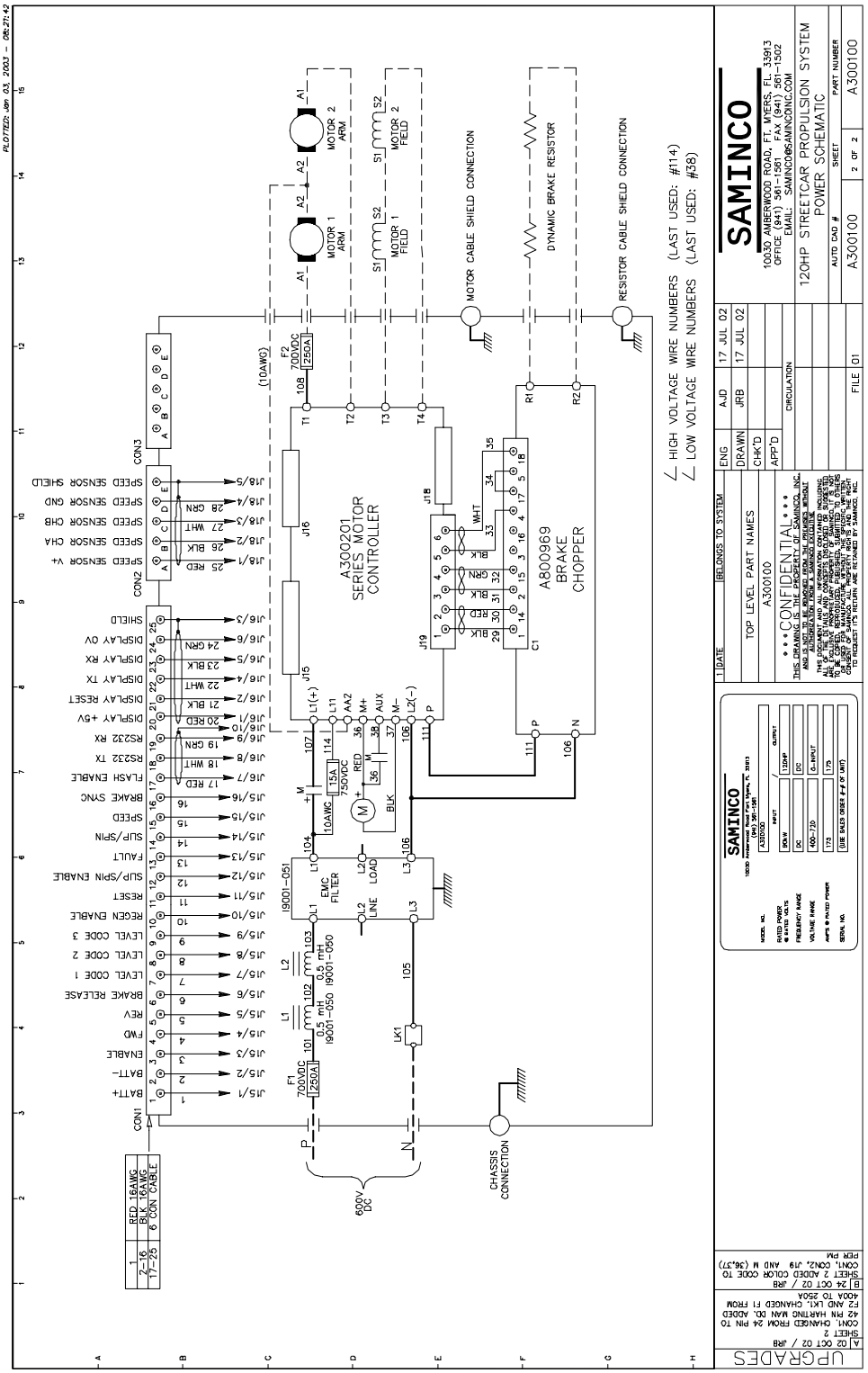
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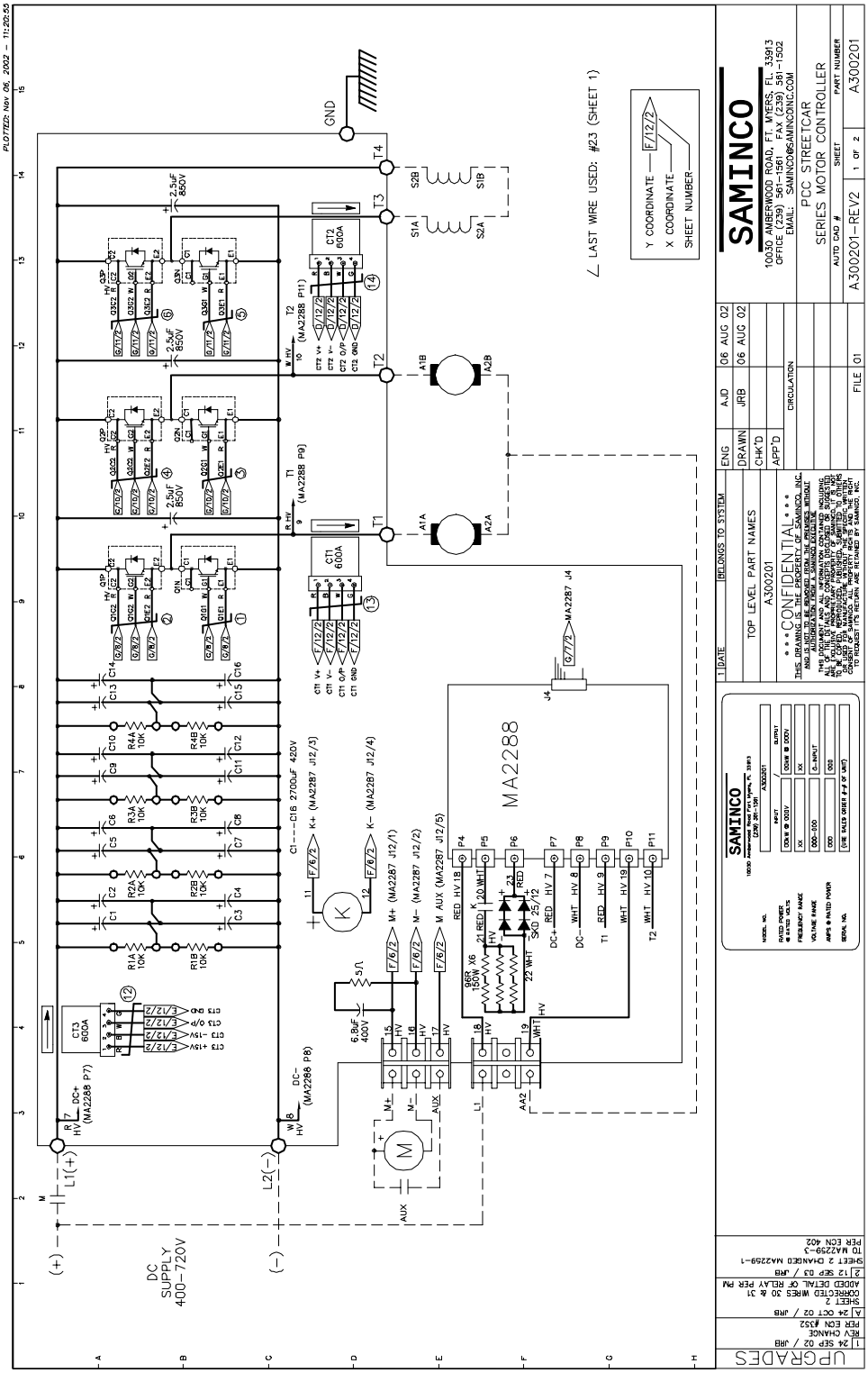
CONTROLLER
A800969
BRAKE
CHOPPER
MOTOR 1
ARM
MOTOR 2
ARM
MOTOR 1
FIELD
MOTOR 2
FIELD
MOTOR CABLE SHIELD CONNECTION
DYNAMIC BRAKE RESISTOR
RESISTOR CABLE SHIELD CONNECTION
CHASSIS
CONNECTION
600V
DC
HIGH VOLTAGE WIRE NUMBERS (LAST USED: #114)
LOW VOLTAGE WIRE NUMBERS (LAST USED: #38)
SAMINCO
10030 AMBERWOOD ROAD, FT. MYERS, FL. 33913
OFFICE (941) 561-1361 FAX (941) 561-1302
EMAIL: SAMINCO@SAMINCOINC.COM
120HP STREETCAR PROPULSION SYSTEM
POWER SCHEMATIC
A300100
2 OF 2
CONFIDENTIAL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PCC STREETCAR
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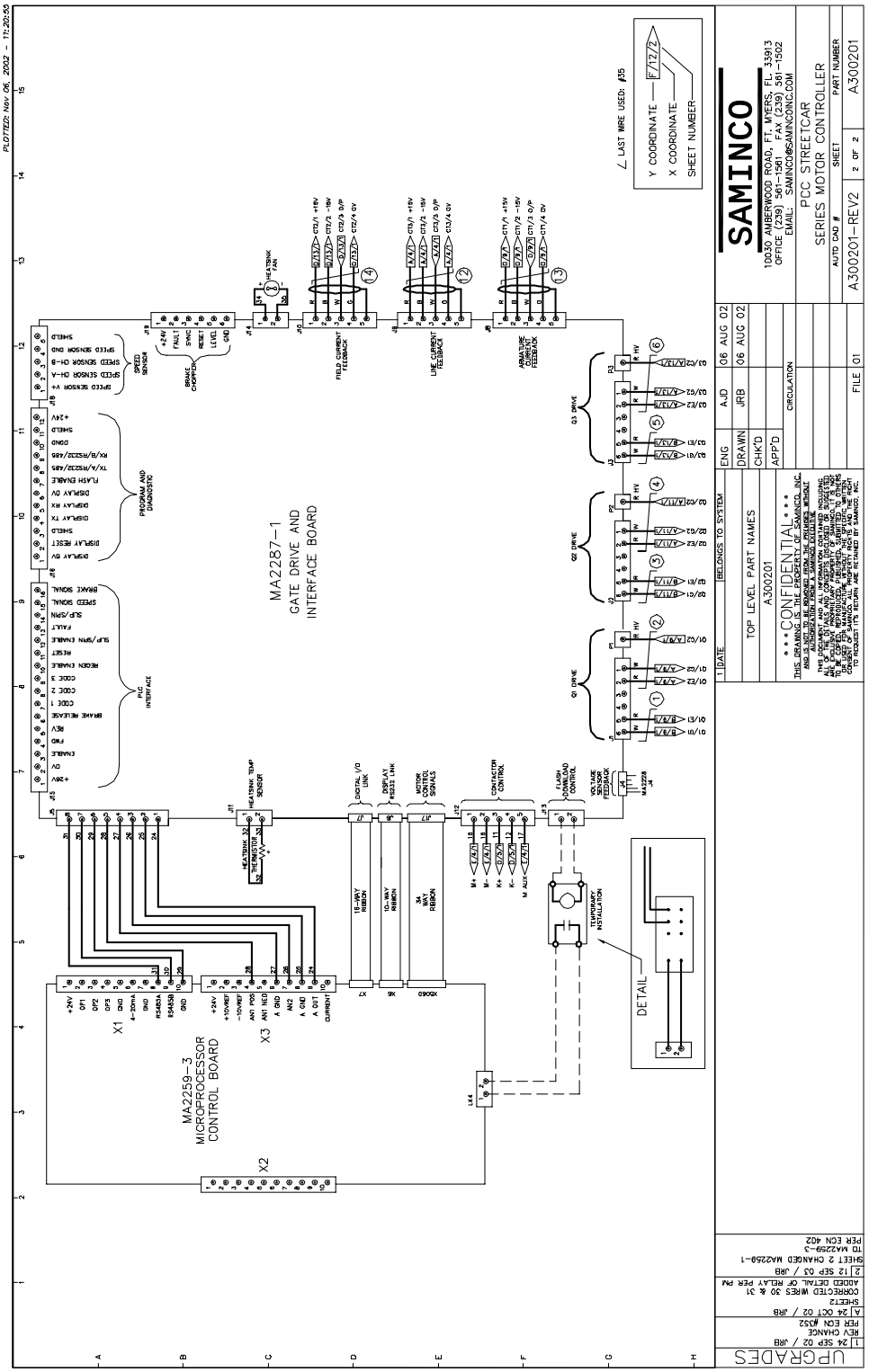
GND
DC SUPPLY 400–720V
L1(+)
L2(–)
M
AUX
CONFIDENTIAL
UPGRADES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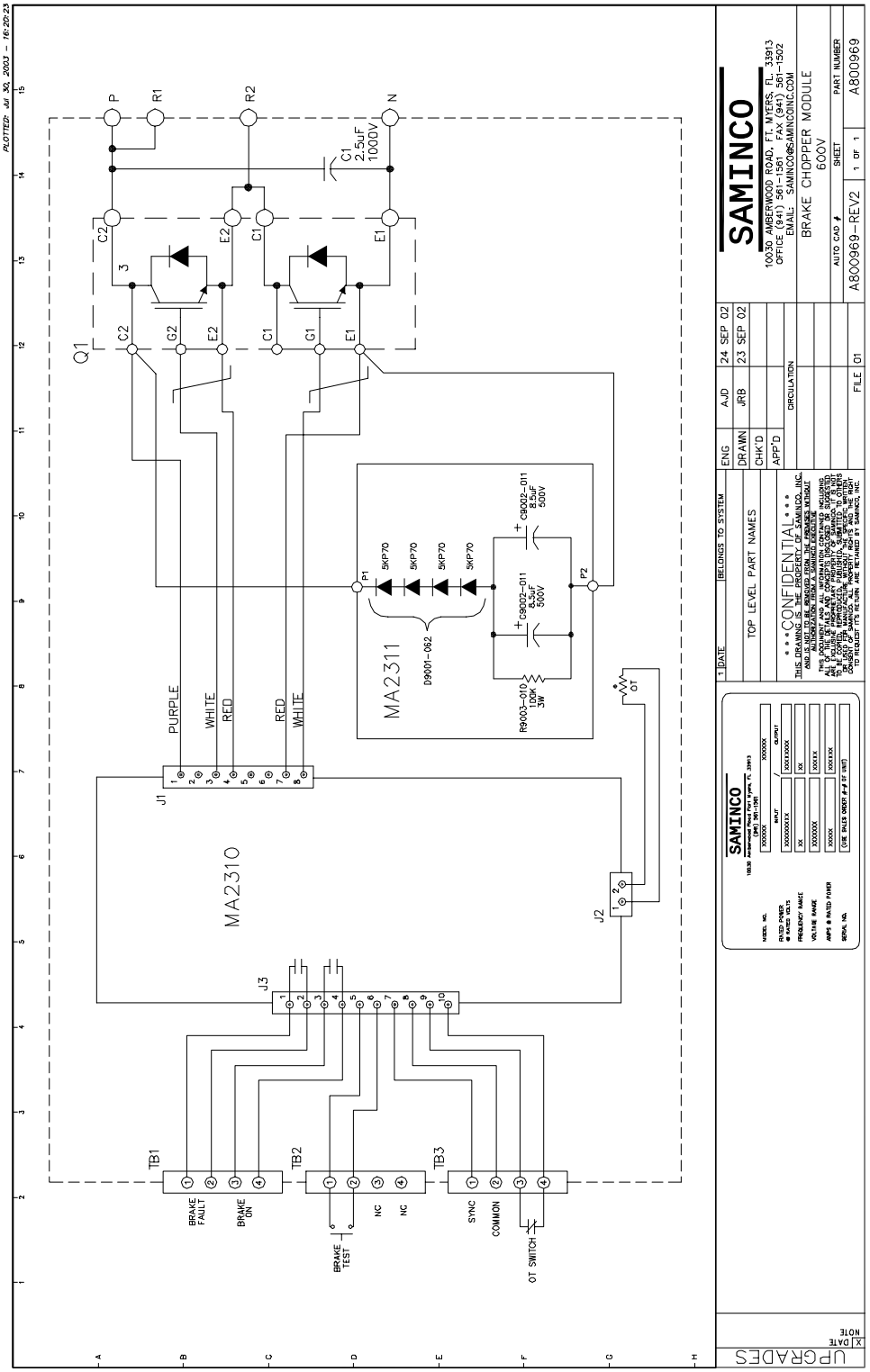
SERIES MOTOR CONTROLLER
A300201
A300201-REV2
MA2287-1
GATE DRIVE AND
INTERFACE BOARD
MA2259-3
MICROPROCESSOR
CONTROL BOARD
DETAIL
Q1 DRIVE
Q2 DRIVE
Q3 DRIVE
PROGRAM AND DIAGNOSTIC
PWM INTERFACE
FIELD CURRENT FEEDBACK
LINE CURRENT FEEDBACK
ARMATURE CURRENT FEEDBACK
SPEED SENSOR
BRAKE CHOPPER
HEATSINK TEMP SENSOR
DIGITAL I/O LINK
DISPLAY RS232 LINK
MOTOR CONTROL SIGNALS
CONTACTOR CONTROL
LASER DISTANCE CONTROL
VOLTAGE SENSOR FEEDBACK
TEMPORARY INSTALLATION
CONFIDENTIAL


SAMINCO
ELECTRIC TRACTION DRIVES
BRAKE CHOPPER MODULE
600V
A800969-REV2
A800969
MA2310
MA2311
D9001-062
Q1
C1
2.5uF
1000V
P
R1
R2
N
C2
E2
C1
E1
G2
G1
3
5KP70
C9002-011
8.5uF
500V
R9003-010
100K
1W
OT
P1
P2
J1
J2
J3
PURPLE
WHITE
RED
RED
WHITE
TB1
TB2
TB3
BRAKE FAULT
BRAKE ON
BRAKE TEST
NC
NC
SYNC
COMMON
OT SWITCH
CONFIDENTIAL
TOP LEVEL PART NAMES
BELONGS TO SYSTEM
DRAWN
CHK'D
APP'D
ENG
AJD
JRB
24 SEP 02
23 SEP 02
10630 AMBERWOOD ROAD, FT. MYERS, FL. 33913
OFFICE (941) 561-1561 FAX (941) 561-1502
EMAIL: SAMINCO@SAMINCOINC.COM
AUTO CAD #
SHEET
1 OF 1
PART NUMBER
FILE
01
UPGRADES
NOTE
DATE

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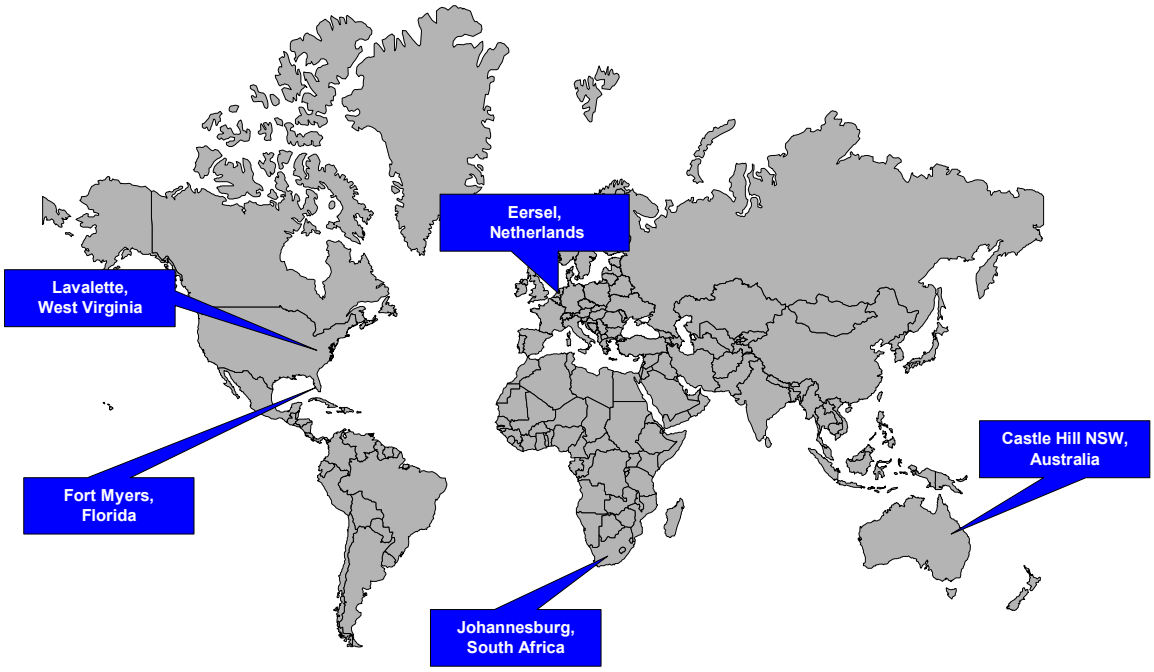
SAMINCO
ELECTRIC TRACTION DRIVES



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